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Bilateral Posterolateral Sulcus Approach for the Removal of Spinal Intramedullary Metastatic Adenocarcinoma: A Technical Case Report

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Abstract

Spinal intramedullary metastasis is an extremely rare event that occurs in advanced cancer. The surgical indications for spinal intramedullary metastasis are highly limited because of surgical difficulty and poor prognosis. In this technical case report, we present a rare case of spinal intramedullary metastasis from the lung that recurred late after local radiation to the spinal cord. The patient progressively experienced relapsed buttock pain and developed gait and urination disorders late after treatment for lung cancer. Imaging examinations suggested the recurrence of spinal intramedullary metastasis in the conus medullaris. Systemic examinations revealed no apparent recurrence in other organs, including the primary lung lesions. Gross total resection of the tumor within the conus medullaris was safely performed using the unilateral posterolateral (PLS) approach and by addition of the contralateral PLS approach. To the best of our knowledge, this is the first case in which a spinal intramedullary metastatic tumor was successfully removed using a bilateral PLS approach.

Keywords: dorsal root entry zone, metastasis, myelotomy, posterolateral sulcus, spinal intramedullary tumor

Introduction

Spinal intramedullary metastasis (SIM) is an extremely rare event in advanced cancer.[1-8] SIM often corresponds to cancer stage 4 when diagnosed, making it difficult for surgeons to determine the surgical indications. In this technical case report, we present a rare case of SIM from the lung that recurred late after local radiation to the spinal cord. Gross total resection of the tumor was safely performed using bilateral myelotomy via the posterolateral sulcus (PLS) on both sides, which is equivalent to the dorsal root entry zone (DREZ) myelotomy (Fig. 1).[9-12] To safely remove the spinal intramedullary metastatic tumor, we described the successful application of a bilateral PLS approach.

Clinical Report

History and presentation

A 56-year-old woman was diagnosed with lung cancer 7 years ago. At that time, the cancer stage was 3A, with T-1b, N-2, and M-0. She underwent thoracoscopic left upper lobectomy, the pathological examination of which resulted in a diagnosis of lung adenocarcinoma. After surgery, the patient received postoperative chemotherapy. The following year, she complained of numbness in her buttocks and posterior thighs and finally developed gait and urination disorders. Imaging examinations suggested the presence of an intramedullary tumor in the conus medullaris (Fig. 2A and B). She received local radiation therapy (53 Gy/29 Fr) for a possible diagnosis of SIM of lung adenocarcinoma and was further treated with molecular targeted therapy using epidermal growth factor receptor-tyrosine kinase in-

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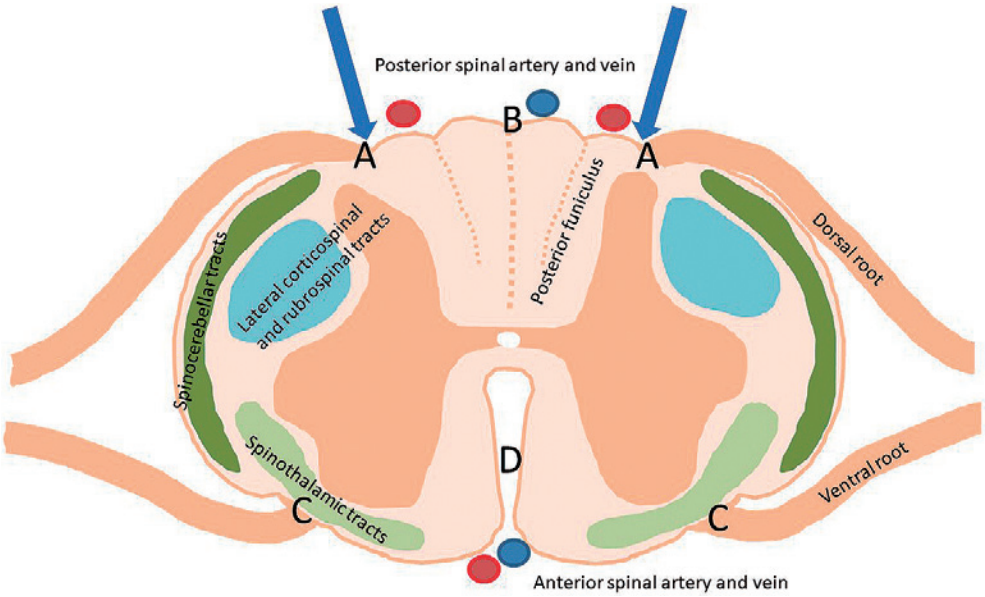

Fig. 1 Schematic drawings of a cross-section of the spinal cord showing the bilateral approach (arrows) to the spinal intramedullary tumor. A: Posterolateral sulcus. B: Posterior median sulcus. C: Anterolateral sulcus. D: Anterior median fissure.

hibitors for 2 years. Her symptoms gradually resolved, and she recovered from the gait and urination disorders (Fig. 2 C and D). Approximately 5 years after radiation therapy, the patient progressively experienced relapsed buttock pain, gait, and urination disorders. Neurological examinations showed moderate weakness and severe sensory impairment in both lower limbs. Imaging examinations suggested a recurrence of the intramedullary lesions in the conus medullaris (Fig. 2E, F and G). Systemic examinations including chest and abdominal contrast-enhanced computed tomography revealed no apparent recurrence in other organs, including the primary lung lesions.

Surgery

The patient was placed in a prone position under general anesthesia. The thorax was elevated 15°, and her head was maintained in neutral flexion without rotation. Transcranial motor-evoked potentials and sensory-evoked potentials were routinely assessed for intraoperative neurophysiological monitoring. Laminectomy was performed in the usual *en bloc* manner. The laminectomy was long enough to expose the entire lesion and widened to the medial pedicular surface. The dura mater was opened while preserving the arachnoid membrane. The arachnoid membrane was also opened with care to avoid damage at the points of arachnoid adhesion or vascular connection. Mild swelling of the spinal cord was confirmed upon initial inspection (Fig. 3A), and it was assumed that the posterior median sulcus (PMS) approach would be technically challenging. As an alternative, the PLS approach from the left side was finally selected. A linear incision along the PLS on the left side was made just over the tumor location after careful inspection of the dorsal nerve rootlets. These dorsal nerve rootlets were attached to the spinal cord along a shallow vertical groove of the PLS, which naturally continued to the posterolateral tract of Lissauer. The crossing vessels were carefully coagulated at very low power under continuous saline irrigation. Myelotomy was extended from the rostral to the caudal side of the tumor by meticulously splaying the spinal cord tissue. Meticulous myelotomy along the left PLS revealed the rostral surface of the tumor (Fig. 3B and C). The tumor-cord interface was well confirmed in the rostral part of the myelotomy; however, the tumor boundaries gradually became obscured at the caudal part of the myelotomy. Another myelotomy was performed on the opposite right side to identify the tumor-cord interface (Fig. 3D). The entire boundary of the tumor was confirmed from the bilateral opening of the myelotomy. Gentle dissection of the tumor-cord interface was continued in the longitudinal plane over the extent of the tumor, and, finally, gross total resection of the tumor was accomplished (Fig. 3E). The shape of the spinal cord was restored by suturing the pial edges together on both sides (Fig. 3F). The waveform of intraoperative neurophysiological monitoring at the end of surgery was almost the same as at the start of surgery.

Postoperative course

Pathological examination of the tumor revealed an atypical epithelial structure and glandular cavity-like arrangement, and a histopathological diagnosis of intramedullary metastatic adenocarcinoma was made. The postoperative course was uneventful. The patient showed satisfactory relief of buttock pain early after surgery, and her

Fig. 2 Serial magnetic resonance images. A, B: T2-weighted and contrast T1-weighted images obtained before radiation showing an intramedullary tumor in the conus medullaris. C, D: T2-weighted and contrast T1-weighted images obtained after radiation showing the clear diminishment of the tumor. E, F, G: T2-weighted and contrast T1-weighted images obtained late after radiation showing tumor recurrence. Note the uneven distribution of enhanced area in the axial images (arrow). H: Contrast T1-weighted images obtained 4 days after surgery showing the reactive enhancement around the cavity of tumor removal. I, J, K: T2-weighted images obtained 2 months (I) , 6 months (J) , and 9 months (K) after surgery showing no tumor recurrence.

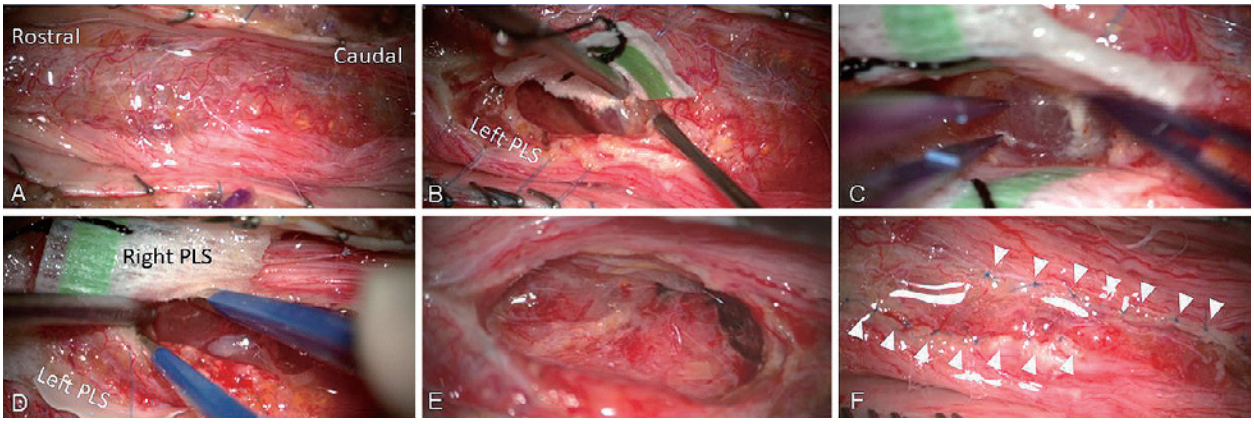

Fig. 3 Intraoperative photographs showing the bilateral posterolateral sulcus (PLS) approach. A: Mild swelling of the spinal cord. B, C: Meticulous myelotomy just along the left PLS revealing the rostral surface of the tumor. D: Another myelotomy on the opposite right PLS suggesting the tumor–cord interface. E: Final stage of the gross total resection of the tumor. F: Suturing the pial edges together on both sides. Note the line of bilateral PLS approach (△).

gait and urination disorders gradually improved. She was eventually able to walk independently on flat ground. Although the recurrence of lung cancer was not clear, chemotherapy was resumed. Imaging examinations early and late after surgery revealed no tumor recurrence (Fig. 2H, I, J and K).

Table 1 Comparison of PMS and PLS approaches for spinal intramedullary tumors

	PMS approach	PLS approach
Indication on MR images	Tumors located in the central area within the spinal cord	Tumors located unevenly within the spinal cord
Advantages	Widely used	Possible benefit of pain relief
	Equal left and right exposures of the tumor	Possible preservation of posterior funiculus
	Anatomically oriented	
Disadvantages	Potential risk of posterior funiculus damage	Selectively used
		Uneven exposure
		Potential risk of lateral funiculus damage

PMS: posterior median sulcus; PLS: posterolateral sulcus; MR: magnetic resonance.

Discussion

Although the patient in this case experienced progressive neurological symptoms, the systemic metastasis of cancer was unclear. The possible diagnoses before surgery included not only SIM of lung cancer but also delayed radiation necrosis or radiation-induced tumors, such as cavernous malformations.[13,14] The PLS approach from the left side was first selected to remove the tumor as it appeared to deviate slightly to the left side. However, the left PLS approach was not sufficient to expose the tumor. Careful intraoperative assessment helped us to perform another myelotomy via the PLS on the right side. Consequently, a bilateral PLS approach was successfully applied.

In general, SIM is very rare, with an estimated reported incidence of 0.2%-3.4% of all metastases.[1-8] When SIM is diagnosed, the patient usually has systemic metastasis, presumed to be cancer stage 4, and the surgical indication for SIM is usually highly limited. Goyal et al. retrospectively reviewed 70 patients with SIM treated in their institution between 1997 and 2016.[7] Only eight of these patients (11%) underwent surgery, with one patient receiving only a biopsy. The primary cancers included the lungs in five patients, prostate in one patient, kidney in one patient, and glioblastoma in one patient. Gross total resection was achieved in four of the eight patients (50%). The authors suggested that surgical management may contribute to the improvement of survival and neurological outcomes in selected patients, although the overall survival in patients with SIM remains poor. Gazzeri et al. performed a retrospective review of clinical data of 30 patients surgically treated for SIM[8] in which lung cancer constituted most of the primary malignancies. Eighteen of the 30 patients (60%) showed symptom improvement in terms of pain relief and partial recovery of motor and/or sensory deficits after surgery. The authors proposed that gross total resection with low morbidity must be the surgical target, and subtotal resection with adjuvant therapy was proposed as a valid therapeutic option in cases wherein gross total resection is not possible.

The PLS approach is equivalent to DREZ myelotomy, which was originally developed for the selective destruction of the posterolateral aspect of the spinal cord, corresponding to the area where the dorsal nerve rootlets enter the spinal cord itself.[15,16] DREZ myelotomy selectively destroys Rexed laminae I through V and Lissauer's tract (dorsolateral tract) while preserving the adjacent dorsal and lateral funiculi. The use of the PLS approach for the removal of spinal intramedullary tumors may be much more destructive to the local area than DREZ myelotomy for the treatment of intractable pain. The advantages and disadvantages of the PLS approach can be compared with those of the standard midline approach via the PMS (Table 1).[9-12] A possible benefit of the PLS approach, compared with that of the PMS approach, is the reduced chance of neurologic deficits related to posterior funiculus damage and acceptable pain relief. However, the possible disadvantages of the PLS approach include the increased risk of neurologic deficits related to lateral funiculus damage, with possible damage to the corticospinal tract on the tumor side. The PLS approach may lead to partial damage of important spinal tracts, such as the corticospinal tract, the rubrospinal tract, and further laterally, the spinocerebellar tract. However, in this case, no serious neurological complications were noted after surgery. The patient demonstrated satisfactory recovery of neurological function early after surgery.

Conclusion

Although tumors showing an uneven location within the spinal cord may be an acceptable indication for the ipsilateral PLS approach, there is no clear agreement on the surgical indication for the bilateral PLS approach. In the present case, the bilateral approach was not planned before the surgery but was eventually performed after careful consideration during the intraoperative inspection. To the best of our knowledge, this is the first case in which a spinal intramedullary metastatic tumor was successfully removed using the bilateral PLS approach.

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Conflicts of Interest Disclosure

No benefits in any form have been or will be received from any commercial party related directly or indirectly to the subject of this manuscript. All authors report no conflicts of interest concerning the materials or methods used in this study or the findings specified in this paper. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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