Surgical Outcomes of Posterolateral Sulcus Approach for Spinal Intramedullary Tumors: Tumor Resection and Functional Preservation

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BACKGROUND: **Selection of the access myelotomy is a key issue in surgery for spinal intramedullary tumors. This study focused on surgical outcomes with the posterolateral sulcus (PLS) approach, equivalent to dorsal root entry zone myelotomy.**

METHODS: **This retrospective study of the 10-year period from 2007 to 2016 included 90 cases of spinal intramedullary lesions (99 operations). A PLS approach was indicated for intramedullary lesions situated laterally in the spinal cord showing no contact with the spinal cord surface. Neurological conditions before and after surgery were carefully assessed objectively.**

RESULTS: **A PLS approach was applied in 34 of the 99 operations (34.3%). Among 70 cases involving astrocytic tumor, ependymal tumor, cavernous malformation or hemangioblastoma, 23 cases (32.9%) were operated on using a PLS approach. Microscopically gross total or subtotal removal of the tumor was achieved in 18 of 23 cases (78.3%). These 18 cases demonstrated mild deterioration of motor function on the approach side early after surgery, but usually resolving within several months postoperatively. Average grade of the modified McCormick functional schema before surgery was maintained 6 months postoperatively. Average grade of the sensory pain scale before surgery was significantly improved by 6 months postoperatively. Segmental dysesthesia on the approach side unexpectedly remained in 2 of 18 cases (11.1%) even late after surgery.**

CONCLUSIONS: **These findings suggest that the PLS approach can provide direct access to tumors with minimal tissue damage, when applied appropriately after careful case selection.**

INTRODUCTION

Surgery for spinal intramedullary tumors remains one of the major challenges for neurosurgeons, due to the relative infrequency, unknown natural history, and difficulty of surgical treatment of these lesions.[1-14] Safe and precise resection of spinal intramedullary tumors, particularly encapsulated benign tumors, is principal for surgeons. Selection of the access myelotomy represents one of the key issues.[15] A posterior median sulcus (PMS) approach still may be standard, but direct transpial or lateral myelotomy from the point at which the lesion can be recognized under the surgical microscope may be suitable for selected cases. We previously have reported our preliminary experience with a posterolateral sulcus (PLS) approach, equivalent to the dorsal root entry zone (DREZ) myelotomy.[16] A PLS approach offers satisfactory exposure of the lesion when applied appropriately. In this retrospective study of a 10-year period, surgical outcomes of the PLS approach for spinal intramedullary tumors were analyzed. The surgical advantages and disadvantages are discussed with reference to the neurosurgical anatomy of the spinal cord.

MATERIALS AND METHODS

Patient Population and Clinical Analysis

A total of 99 operations were performed in 90 cases of spinal intramedullary lesions during the 10-year period from 2007 to 2016 in our institute. Cases of myxopapillary ependymoma arising from

Key words
- Functional preservation
- Myelotomy
- Pain
- Posterior median sulcus
- Posterolateral sulcus
- Spinal intramedullary tumor
- Tumor resection

Abbreviations and Acronyms
DREZ: Dorsal root entry zone
MR: Magnetic resonance
PLS: Posterolateral sulcus
PMS: Posterior median sulcus

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Table 1. Modified McCormick Functional Schema and Sensory Pain Scale

Grade	Definition
1	Neurologically normal; mild focal deficit not significantly affecting limb function; mild spasticity or reflex abnormality; normal gait
2	Presence of sensorimotor deficit affecting function of involved limb; still functions and ambulates independently; mild gait difficulty
3	Presence of sensorimotor deficit affecting function of involved limb; still functions and ambulates independently; moderate gait difficulty
4	More severe neurologic deficit; requires cane/brace for ambulation or significant bilateral upper-extremity impairment; may or may not function independently
5	Severe deficit; requires wheelchair or cane/brace with bilateral upper-extremity impairment; usually not independent
Grade	**Definition**
1	No symptoms
2	Mild pain or dysesthesia, slightly impairing QOL
3	Moderate pain or dysesthesia, fairly impairing QOL
4	Severe pain or dysesthesia, significantly impairing QOL

QOL, quality of life.

the conus medullaris were excluded from this study. All medical records on a computerized medical records system (EGMAIN-EX; Fujitsu, Tokyo, Japan) were analyzed retrospectively. Neurologic conditions before and after surgery carefully were assessed objectively with the modified McCormick functional schema and sensory pain scale (Table 1).[6,16-18] Surgical record details of spinal intramedullary tumors are summarized in Table 2.

Surgical Indications for the PLS Approach

Tumor access to the intramedullary lesion was determined carefully based on preoperative diagnostic imaging, as well as operative inspection of the spinal cord surface. A PMS approach preferably was applied for most gliomas, such as ependymoma and astrocytoma, whereas a direct transpial or lateral myelotomy approach from a point at which the lesion was recognized under the surgical microscope was considered suitable for subpial-growing or vascular tumors such as hemangioblastoma. The PLS approach was indicated for intramedullary lesions situated laterally in the spinal cord that were not in contact with the posterior or lateral surfaces of the spinal cord on magnetic resonance (MR) images before surgery. In cases in which MR images before surgery clearly suggested central growth of a tumor such as ependymoma, the PLS approach was not indicated. When conventional MR images such as T1- or T2-weighted images failed to adequately clarify tumor location in the axial plane, the precise location of the tumor was assessed with contrast-enhanced constructive interference in steady-state MR imaging or myelographic MR imaging using true fast imaging with steady-state precession sequences.

Surgical Technique

The patient was placed in the lateral oblique (45°) position under general anesthesia (Figure 1).[5,9,15-17] The side on which the tumor was located was placed upper-most. The thorax was elevated 15°, and the head was maintained in neutral flexion without rotation. The lateral oblique position can permit a fixed spine in good microscope focus throughout the respiratory cycle, as well as good control of epidural venous pressure. Oozing blood drains out of

Table 2. Surgical Summary of Spinal Intramedullary Tumors (2007–2016)

Pathologic Type	WHO Grade	No. of Cases	No. of Operations	Spine Level	
				Cervical	Thoracic
Astrocytic tumor	1	1	2	1	
	2	4	6	1	3
	3	2	2	1	1
	4	1	1		1
Ependymal tumor	1	3	3	2	1
	2	28	29	21	7
	3	2	2	2	
Cavernous malformation		13	13	9	4
Hemangioblastoma		16	21	10	11
Metastatic tumor		6	6	3	3
Miscellaneous		14	14	5	9
		90	99	55	40

WHO, World Health Organization.