 ISSN - 2250-1991 | IF : 5.215 | IC Value : 77.65

Research Paper | Medical Science

Feasibility of the Posterior Approach for Removal of Ventrolateral Extended Intradural Tumors

* Koichi Iwatsuki	Department of Neurosurgery, Osaka University Medical School, Suita, Osaka, Japan. * Corresponding Author.
Yu-ichiro Ohnishi	Department of Neurosurgery, Osaka University Medical School, Suita, Osaka, Japan
Koshi Ninomiya	Department of Neurosurgery, Osaka University Medical School, Suita, Osaka, Japan
Toshika Ohkawa	Department of Neurosurgery, Osaka University Medical School, Suita, Osaka, Japan
Toshiki Yoshimine	Department of Neurosurgery, Osaka University Medical School, Suita, Osaka, Japan

ABSTRACT

Management of ventral intradural spinal tumors is usually achieved through a posterior approach. However, a posterolateral approach may be required for some ventral lesions contralateral from the approach side. The authors describe the feasibility of these approaches of ventral intradural lesions and present the surgical outcomes in these cases. There were 19 cases of ventral intradural lesions: 9 meningiomas, 9 schwannomas, and 1 neurenteric cyst. Seven of these were cervical and 12 were thoracic lesions. Tumors were removed through a space between the dura and spinal cord without retraction and rotation of the spinal cord. Fourteen and five cases required posterior and posterolateral approaches, respectively. Two lesions in the thoracic spine required laminectomy with partial facetectomy, and 3 in the thoracic spine required facetectomy and transversectomy. To evaluate the extent of tumor localization, the tumor localized angles were measured on axial cross-sections. Larger tumor localized angles indicated larger ventrolateral extension of tumors. The posterior approach could not be employed for five tumors in the thoracic spine that showed tumor localized angle over 215 . Tumors were completely removed in 18 patients, whereas 1 patient underwent a subtotal resection. All patients had improved neurological status. Although posterior approaches provide adequate exposure to safely remove the majority of these lesions, the posterolateral approach was needed to expose tumors with ventrolateral extension. However, future studies with more ventral intradural spine tumor cases are required to fully elucidate these findings.

KEYWORDS ventrolateral, posterior, posterolateral, intradural extramudurally tumors

Introduction

Adequate exposure to ventral intradural tumors can be attained via posterior or posterolateral approaches. The posterior approach is the most common method used by spinal neurosurgeons.[1-2] Ventral intradural tumors can usually be removed through internal tumor decompression into the resection cavity. However, ventral intradural tumors with severe spinal cord compression and significant contralateral tumor extension, but without spinal cord rotation or lateral displacement, can be difficult to safely remove using a posterior approach. In such cases, direct visualization is required for safe dissection to avoid injury. The posterolateral approach involves the removal of the facet joint, pedicle, or transverse process. Posterolateral approaches provide a tangential trajectory to the ventral or ventrolateral dissection planes.[3-7]

The purpose of this study was to review our experience with a surgical series of 15 cases involving patients with ventral intradural tumors, and discuss the feasibility of surgical management by posterior and posterolateral approaches based on the size and extent of the ventral tumors.

Methods

Nineteen patients (3 men and 16 women; mean age, 61.3 years) with ventral intradural spinal pathology underwent surgeries between 2009 and 2014 at our institution. Tumors were located at the cervical spine in 7 cases and at the thoracic spine in 12. There were 9 meningiomas, 9 schwannomas, and 1 neurenteric cyst. Gait disturbance was the most common symptom but all patients were able to ambulate at the time of surgery (Table 1).

Table 1. Clinical data of 19 patients with ventral intradural lesions.

Case	Sex	Age	Pathology	Level	Removal extent	Neuro-logical symptoms	MMS		Approach	Occupation ratio (%)	Localized angle (degrees)		Follow -up (months)
							Pre	Post			From	To	
1	♀	52	meningioma	C1	GTR	M	3	1	Lami	52.6	22.5	150	38
2	♀	61	meningioma	C1	GTR	M, GD	4	1	Lami	81.7	-45	230	15
3	♂	75	schwannoma	C2	GTR	M, GD	3	1	Lami	59.2	5	180	15

4	♀	41	meningioma	C6	GTR	M	3	1	Hemilami	67.1	45	247.5	21
5	♀	42	schwannoma	C6	GTR	M, R	3	1	Hemilami	88.4	0	180	28
6	♂	75	schwannoma	C6	GTR	M, R, GD	3	2	Hemilami	50.1	45	180	35
7	♀	56	schwannoma	C7	GTR	M	2	1	Lami	50.5	22.5	180	26
8	♂	78	schwannoma	T1	GTR	N, M	3	1	Lami	86.1	0	240	69
9	♀	74	meningioma	T1	GTR	M, GD	3	1	Lami	69.1	0	225	39
10	♀	51	meningioma	T2	GTR	M, GD, VS	3	2	Lami	61.7	5	205	21
11	♀	42	meningioma reccurrence	T2	GTR	M, GD	2	2	Lami + F + RP	70.9	15	215	6
12	♀	72	meningioma	T3	GTR	M, GD	3	1	Lami + PF	71.2	5	225	41
13	♀	79	neurenteric cyst	T5	STR	M, GD	3	1	Lami	85.6	60	240	41
14	♀	53	schwannoma	T5	GTR	M, GD	3	1	Hemilami + F + RP	74.5	22.5	225	6
15	♀	65	meningioma	T8	GTR	M, GD	3	1	Lami + PF	75.5	45	225	77
16	♀	73	schwannoma	T9	GTR	M, GD	3	2	Hemilami + F + RP	80.6	10	350	15
17	♀	66	schwannoma	T9	GTR	M, GD	3	1	Hemilami	68.7	-15	80	7
18	♀	30	schwannoma	T10	GTR	BP, M	2	1	Hemilami	65.7	22.5	205	6
19	♀	81	meningioma	T10	GTR	BP, GD	3	1	Lami	60.2	45	225	47

BP, back pain; F, facetectomy; GD, gait disturbance; Hemilami, hemilaminectomy; Lami, laminectomy; M, myelopathy; N, neck pain; PF, partial facetectomy; R, radiculopathy; RP, removal of pedicle; VS, voiding symptoms

Voiding symptoms such as incontinence or difficulty of initiation were present in one patient. Magnetic resonance imaging (MRI) was performed in all cases pre- and postoperatively. The clinical follow-up period was 29.1 ± 20.1 months (range = 6–69 months). Details of the patient characteristics, treatment approaches, and follow-up periods are given in Table 1. Each patient's pre- and postoperative clinical status was evaluated with the modified McCormick scale, ranging from grade I–V: I = normal gait, II = mild gait disturbance not requiring support, III = gait with support, IV = assistance required, and V = wheelchair needed.[8,9] Preoperatively, fifteen patients were classified under grade 3, three in grade 2, and one in grade 4.

The extent of tumor removal was evaluated by findings during surgery and postoperative MRI. Recurrence was defined as a new onset or worsening of symptoms and/or radiological confirmation of tumor growth.

The greatest axial tumor size and canal size were measured on axial cross-sections using gadolinium-enhanced or non-enhanced T1-weighted MRI with ImageJ (version 1.48). The ratio of area occupied (100 × tumor area/canal area, expressed as %) was calculated in each patient. To evaluate the extent of tumor localization, the tumor angles were measured on axial cross-sections using gadolinium-enhanced or non-enhanced T1-weighted MRI using Image J. This angle was defined between 0° and 360°. The 0° is the dorsal midpoint, and 180° is the ventral midpoint. The approach side was between 0° and 180°, and the contralateral side was between 180° and 360°. Larger angles indicated larger ventrolateral extension of tumors.

Operative technique
The choice between right- and left-sided surgical approaches was made on the basis of the direction of spinal cord deviation. Under general anesthesia, the patients were placed in the prone position. The neck was maintained in a slightly flexed position with a Mayfield head clamp for cervical spine lesions. A midline or L-shaped incision was extended downward through the ligamentum nuchae. Subperiosteal exposure of the posterior spinal elements was performed on the affected side. The muscle dissection was continued laterally to expose the entire facet joint at the affected level. The decision to perform laminectomy or hemilaminectomy depended on the identification of the dissection plane between the spinal cord and tumors. Hemilaminectomy or laminectomy was performed with a high-speed drill. The lateral bone resection provided adequate exposure for the ventrolateral extended tumors.

After opening the dura, the tumor was identified over or around the dentate ligaments. The dentate ligaments were cut, and the volume of tumors was reduced as follows. Tumors were removed through a space between the dura and spinal cord without retraction of the spinal cord. Tumor capsule was incised through the gap and the content of the tumor within the tumor capsule was removed with an ultrasonic aspirator. After internal decompression of the tumor, we were able to extract the tumor by applying careful traction, followed by further decompression. The arachnoid or pia membrane between the tumor and spinal cord was used as the dissection plane. The rootlet or rootlets from which the schwannomas originated were cut with the tumor after intraoperative electrical stimulation to confirm lack of activity. For meningiomas, after gross removal, their place of origin from the dura was coagulated (Simpson grade II). Somatosensory evoked potentials were determined in all cases. There were no intraoperative changes in the somatosensory evoked potential in any patient.

Results
Tumors were completely removed in 18 patients (Table 1), whereas one patient underwent a subtotal resection (patient 13). There were no cases of recurrence during the follow-up period. Fourteen and five cases required posterior and posterolateral approaches, respectively. The posterior approach could not be employed for five tumors in the thoracic spine that showed occupation ratio over 70% and tumor localized angle over 215° and one tumor with occupation ratio over 80% and tumor localized angle over 350°; two tumors required par-

tial facetectomy and three tumors required facetectomy and transversectomy (Fig. 3-5). Tumor occupation ratio was 69.4 ± 11.8% (range = 50.1–88.4%) (Table 1). Tumor localized angles ranged from 16.3 ± 25.0° to 210.9 ± 51.9° (Table 1). In the postoperative Modified McCormick scale, sixteen patients were classified under grade 1, and three patients were classified under grade 2. All patients showed improved neurological status. There were no operative and postoperative complications.

Discussion

In this case series, tumors were completely removed in 18 patients whereas one patient underwent a subtotal resection. A residual tumor capsule in patient 13 adhered to the ventral spinal cord, but presented no recurrence during the 4-year follow-up. Neurological symptoms improved in all patients according to the Modified McCormick scale. None of the patients showed aggravation of neurological symptoms. The contralateral extended ventral tumors in the cervical spine could be completely removed using a posterior approach through a laminectomy or hemilaminectomy. In the thoracic spine, the contralateral extended ventral tumors were removed by laminectomy with partial facetectomy, and hemilaminectomy with facetectomy and transversectomy.

Ventral access to C1-2 lesions can be readily achieved via a posterior approach because of the relatively broad spinal canals and the ventral location of the atlanto-axial joints and ligament attachments.[10)] These anatomical characteristics allow a wider lateral bone removal to gain better lateral and ventral access without the risk of spinal instability. However, the spinal canal at the subaxial level is relatively narrow. The risk of instability is greater at these levels because of the need for partial facetectomy to gain adequate ventral access.[11)] The thoracic spinal canal is small; therefore, the trajectory to the ventral canal can be achieved through more lateral resection of the facet joint, proximal rib and transverse process, and the pedicle.[3)]

The anatomical orientation of the posterior approach is familiar to surgeons, and there is no need for spinal stabilization during the posterior approach after a conventional laminectomy is performed.[12,13)] Kim et al. have reported that large ventral intradural tumors can be completely removed using a posterior approach and conventional laminectomy.[2)] However, they presented no data on the degree of tumor extension to the contralateral ventral side. Even large tumors with an occupation ratio over 70% can be resected via the posterior approach if they do not show contralateral extension (Table 1). Angevine et al. reported that posterior exposures with lateral bone resection provided adequate exposure for safe removal of ventrolateral tumors.[1)] Dissection between the tumor and spinal cord may cause trauma to the spinal cord if adhesions are present.[10)] When the tumor adheres to the spinal cord, it is impossible to remove it completely using the posterior approach.[7,14,15)] Any significant degree of ventral intramedullary extension is extremely difficult to safely access from a posterolateral trajectory.

In this case series, tumors with an occupation ratio over 70% included two in the cervical spine and seven in the thoracic spine. Tumors with a localized angle over 215° included two in the cervical spine and nine in the thoracic spine. In the cervical spine, there is no blockade through a trajectory to the ventral canal and hence, the canal space is wider than that in the thoracic spine. Therefore, even if tumors have both an occupation ratio over 70% and a localized angle over 215°, they could be removed via a posterior approach. However, in the thoracic spine, the scapula, costal bones, and the shape of the thoracic spine block a trajectory to the ventral canal. Therefore, facetectomy and transversectomy were needed to prevent spinal cord retraction and acquire sufficient operative view. In this case series, five cases with both occupation ratio over 70% and tumor localized angle over 215° needed partial facetectomy. Three in these cases needed facetectomy and transversectomy. Although larger angles indicate larger ventrolateral extension of tumors, the tumor localized angle cannot provide a measure of the posterolateral approach because of the small sample size in this study. Surgeons should use the tumor localized angle as a reference for the decision regarding resection of lateral thoracic bones, and also consider the pathology, recurrence, and intramedurally extension of tumors.

Conclusions

Here, we have described the feasibility of posterior and posterolateral approaches for ventral intradural tumors. Although posterior approaches provide adequate exposure to safely remove the majority of these lesions, posterolateral approaches are needed to remove tumors showed ventrolateral extension and large occupation ratios. However, there are limitations to this study because of the small sample size. Therefore, future studies with more ventral intradural spine tumor cases are required to fully elucidate the findings of this study.

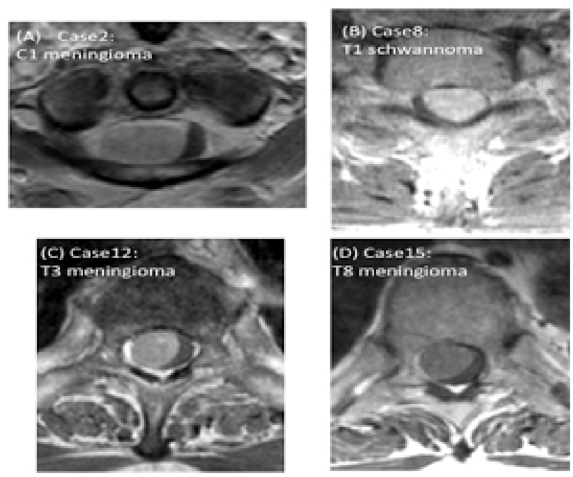
Acknowledgement

We thank Y. Takahashi for administrative assistance.

Disclosure

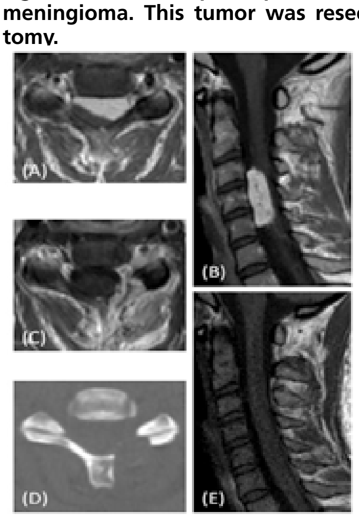
The authors declare no conflicts of interest with respect to the authorship or publication of this article. This study was supported by a Grant-in-Aid for Scientific Research (C) and a Health Labour Sciences Research Grant.

Figure 1. Representative preoperative axial MR images of ventral intradural lesions.



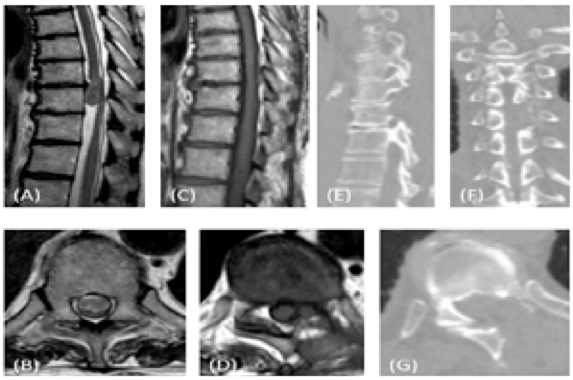
(A) Case 2: C1 meningioma. (B) Case 8: T1 schwannoma. (C) Case 12: T3 meningioma. (D) Case 15: T8 meningioma. Case 2 and 8 were treated by posterior approach. Case 11 and 13 were resected by the posterolateral approach.

Figure 2. Pre- and post-operative images of Case 4: C6 meningioma. This tumor was resected by hemilaminectomy.



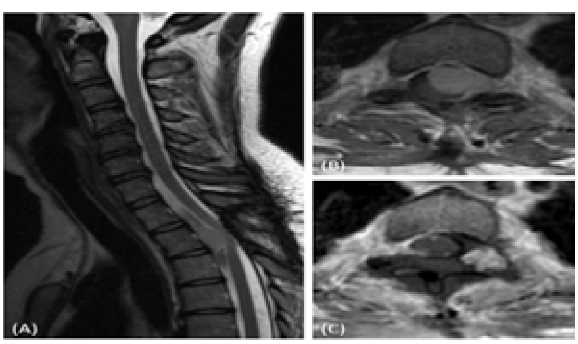
(A) pre-operative contrast enhanced axial MR images. (B) pre-operative contrast enhanced sagittal MR images. (C) post-operative contrast enhanced axial MR images. (D) post-operative CT images. (E) post-operative contrast enhanced sagittal MR images.

Figure 3. Pre- and post-operative images of Case 16: T9 meningioma. This patient was treated by hemilaminectomy with partial facetectomy and transversectomy.



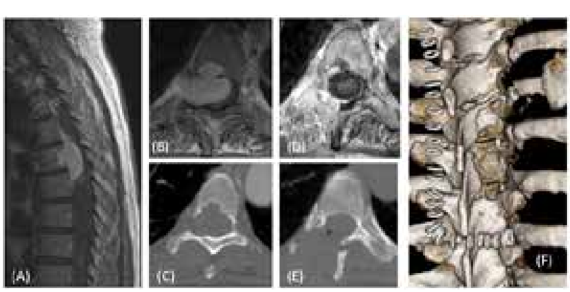
(A) pre-operative sagittal T1WI. (B) pre-operative axial T1WI. (C) post-operative sagittal T1WI. (D) post-operative axial T1WI. (E) post-operative sagittal CT images. (F) post-operative coronal CT images. (G) post-operative axial CT images.

Figure 4. Pre- and post-operative images of Case 11: T2 recurrence meningioma. This patient was treated by laminectomy with facetectomy and transversectomy.



(A) pre-operative sagittal T2WI. (B) pre-operative contrast enhanced axial MR images. (C) post-operative contrast enhanced axial MR images. Fat tissue was placed on the post-operative cavity.

Figure 5. Pre- and post-operative images of Case 14: T5 schwannoma. This patient was treated by hemilaminectomy with partial facetectomy and transversectomy.



(A) pre-operative contrast enhanced sagittal MR images. (B) pre-operative contrast enhanced axial MR images. (C) pre-operative CT images. (D) post-operative contrast enhanced axial MR images. (E) post-operative axial CT images. (F) post-operative 3D reconstructed CT images.

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