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Original Article

Posterolateral approach for spinal intradural meningioma with ventral attachment

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Abstract

Background: Spinal meningioma with ventral attachment is a challenging pathology. Several technical modifications have been proposed to secure safe and precise resection of these tumors. **Materials and Methods:** This retrospective study focused on the precise and safe surgery of spinal meningiomas with strictly ventral attachment of cervical or thoracic spine. The surgical technique included a lateral oblique position for the patient, laminectomy with unilateral medial facetectomy on the tumor side, and spinal cord rotation with the dentate ligament. The neurological status of patients was assessed using the modified McCormick functional schema (mMFS) and sensory pain scale (SPS) before and at least 3 months after surgery. Patients were followed-up for a mean of 23.7 months. Tumor removal was graded using the Simpson grade for removal of meningiomas, and the extent of excision was confirmed using early postoperative magnetic resonance imaging. **Results:** Simpson grade 1 or 2 resections were achieved in all cases. No major surgery-related complications were encountered, postoperatively. The mean mMFS score before surgery was 3.1, improving significantly to 1.7 after surgery ($P < 0.05$). The mean SPS score before surgery was 2.4, improving significantly to 1.6 after surgery ($P < 0.05$). **Conclusions:** This surgical technique offers a posterolateral surgical corridor to the ventral canal of both cervical and thoracic spine. The present preliminary analysis suggests that functional outcomes were satisfactory with minimal surgery-related complications, although considerable surgical experience is needed to achieve a high level of surgical confidence.

Key words: Extramedullary, meningioma, posterolateral approach, spinal cord tumor, ventral

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INTRODUCTION

Spinal meningioma is a common intradural spinal tumor. Although this pathology responds favorably to surgical excision, surgical management may be impacted by several factors, including the neurological condition of the patient, tumor size, tumor location, spinal level, and anatomical relationship with the spinal cord.[1-9] In particular, spinal meningioma with ventral attachment remains a challenging issue for spine surgeons. Several technical modifications have been proposed to secure safe and precise tumor resection.[10-14] In this paper, our posterolateral approach, which enables the surgeon to take a relatively narrow but direct surgical corridor to the ventral canal, is presented.

MATERIALS AND METHODS

Patients

This retrospective study covered the 5-year period between 2010 and 2014 and included 7 patients who had undergone removal of a spinal meningioma with strictly ventral attachment. The participants were 2 men and 5 women, with a mean age of 59.3 years (range, 23-85 years). Tumors were located in the subaxial cervical spine from C3 to C7 in 3 cases, and at the thoracic spine in 4 cases. Tumors of the craniovertebral junction and lumbar spine were excluded from the present study. Recurrent tumors were also excluded. The neurological status of each patient was assessed using the modified McCormick functional schema (mMFS) and sensory pain scale (SPS) before and at least 3 months after surgery [Table 1].[15-18] Patients were followed for a mean of 23.7 months (range, 6-42 months). Tumor removal was graded using the Simpson grade for removal of meningiomas, and the extent of excision was confirmed by early postoperative magnetic resonance imaging (MRI) studies.[19]

Table 1: mMFS and sensory pain scale

Grade	Definition
I	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 neurological 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 w/ bilateral upper-extremity impairment; usually not independent
Grade	Definition
I	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, mMFS: Modified McCormick functional schema

Surgical technique

The patient was placed in the lateral oblique (45°) position under general anesthesia, with the tumor located on the upper side [Figure 1]. The thorax was elevated 15°, and the head was maintained in neutral flexion without any rotation. All pressure points were securely padded to avoid any venous congestion or peripheral nerve injury. This was particularly comfortable for the surgeon and met the need for both spinal immobilization and absence of abdominal pressure. Transcranial motor evoked potentials were routinely used for intraoperative neurophysiological monitoring.

Laminectomy was performed in the usual en bloc manner. The laminectomy was made long enough to expose the entire lesion and widened to the medial pedicular surface. Medial facetectomy was added to the tumor side. 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 adherence or vascular connection [Figure 2a]. The dentate ligament was carefully resected from the inner surface of the dura mater and drawn back to the opposite side. The spinal cord was gently rotated and fixed to make a posterolateral surgical corridor [Figures 2b and 3a]. The surgical technique enables the surgeon to take a relatively narrow but direct surgical corridor to the ventral canal [Figure 4]. The tumor was removed in piecemeal fashion or resected sharply with minimal manipulation of the spinal cord with the help of internal decompression [Figure 3b and c]. Bipolar cautery was helpful for shrinking the tumor. The body of the patient can be angled to enhance the surgical corridor. After tumor removal, the dural attachment of the tumor was completely resected (Simpson grade 1) [Figure 3d] or coagulated meticulously (Simpson grade 2) to achieve complete resection of Simpson grade 1 or 2. In cases where the dural attachment of the tumor was completely resected in younger patients, autologous fascia lata was grafted to repair the defect in the dura mater [Figure 3e]. After complete resection of the tumor, rotation of the spinal cord was secured to the original position [Figure 3f]. Resected laminae were constructed in lift-up style for the cervical spine or onlay style

Figure 1: Lateral oblique position in a case of Th5 ventral meningioma (patient 7)

for the thoracic spine using a titanium mini-plate and screws.[20] No rigid orthosis was applied after surgery. Supplemental digital content of surgical video Patient 7 was provided.

Statistical analysis

Statistical comparisons between the two study groups were performed with the Wilcoxon signed rank test. JMP version 9.0 software (SAS Institute, Cary, NC, USA) was used for all statistical analyses in the present study. Values of $P < 0.05$ were considered significant.

Statement of ethics

We certify that all applicable institutional and governmental regulations concerning the ethical use of clinical data were followed in the present study. Written informed consent was obtained from the patients. This comprehensive analysis of surgery-related outcomes was approved by the ethics committee of Osaka City University Graduate School of Medicine.

RESULTS

Simpson grade 1 or 2 resections were achieved in all cases. Mean estimated blood loss during surgery was 125 mL. Although no major surgery-related complications were encountered, minor complications of superficial wound trouble (case 4) and cerebrospinal fluid leakage (case 5) were recognized early after surgery. No cases required re-operation because of tumor regrowth during follow-up. The characteristics of all patients are summarized in Table 2.

Functional outcomes were assessed at least 3 months, postoperatively. Overall analysis according to the mMFS between before and after surgery demonstrated improvement in 5 cases and stable results in 2 cases. The mean mMFS score before surgery was 3.1, improving significantly to 1.7 after surgery ($P < 0.05$). Overall analysis according to the SPS demonstrated improvement in 3 cases, and 4 cases were

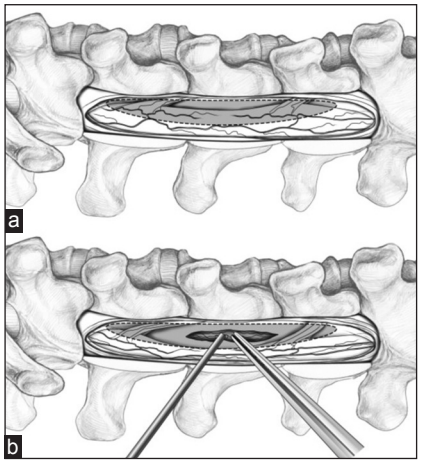

Figure 2: Schematic drawings demonstrating the surgical steps. (a) Spinal meningioma with ventral attachment is covered by the spinal cord. (b) The dentate ligament is carefully resected, stitched, and drawn back to the opposite side. The spinal cord is gently rotated and fixed to make a posterolateral surgical corridor

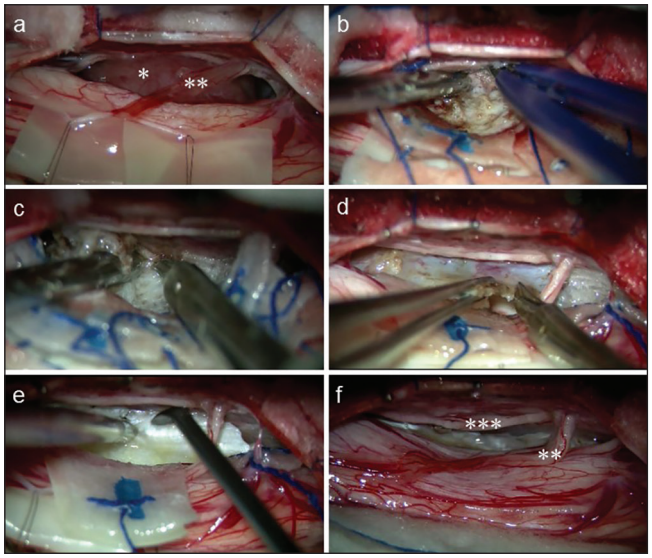

Figure 3: Operative photographs taken during surgery in case 7. (a) The spinal cord is gently rotated and fixed to create a wider posterolateral surgical corridor after the dentate ligament is drawn back to the opposite side. (b) The tumor is removed in piecemeal fashion with minimal manipulation of the spinal cord with the help of internal decompression. (c) The tumor is resected sharply in the final step of tumor removal. (d) Dural attachment of the tumor is resected completely to achieve complete resection of Simpson grade 1. (e) Autologous fascia lata is grafted to repair the resected dura mater. (f) After complete resection of the tumor, rotation of the spinal cord is secured to the original position. Please note the tumor (*), posterior nerve root (**) and anterior nerve root (***)

Table 2: Summarized characteristics of all patients

Patient number	Age	Sex	Spine level	Simpson grade	Blood loss during surgery (mL)	Pathology	Postoperative follow-up (months)	Recurrence
1	74	Female	C2-C4	2	100	Meningothelial	20	—
2	70	Male	C2-C3	2	230	Microcystic	42	—
3	23	Female	Th8-Th10	1	90	Psammomatous	40	—
4	85	Female	Th7-Th8	2	90	Metaplastic	30	—
5	73	Male	C5-C7	1	80	Fibrous	21	—
6	54	Female	Th2-Th3	2	230	Fibrous	7	—
7	36	Female	Th5-Th6	1	55	Meningothelial	6	—

C: Cervical, Th: Thoracic

stable. The mean SPS score before surgery was 2.4, improving significantly to 1.6 after surgery ($P < 0.05$).

Illustrative case 1

Case 2: A 70-year-old man presented with a 6-month history of moderate left dysesthesia and gait disturbance. Neurological examination revealed moderate sensory impairment of the left upper extremity and mild spastic gait. Assessment of the neurological condition before surgery suggested grade 3 on the mMFS and grade 2 on the SPS. T2- and enhanced T1-weighted MRI of the cervical spine revealed an intradural tumor at the C2/3 level with severe compression of the spinal cord [Figure 5a-c]. Simpson grade 2 resection of the tumor was accomplished. Pathological examination verified the diagnosis of microcystic meningioma. The patient developed painful dysesthesia of the right upper extremity early after surgery, but this gradually improved with the help of supportive pharmacological care. T2- and enhanced T1-weighted MRI obtained postoperatively showed complete tumor removal [Figure 5d]. Assessment of the neurological condition at the most recent follow-up suggested grade 1 on the mMFS and grade 2 on the SPS.

Illustrative case 2

Case 6: A 54-year-old woman presented with a 10-month history of back pain and gait disturbance. Neurological examination revealed severe sensory impairment in both lower extremities and moderate spastic gait. Assessment of the neurological condition before surgery suggested grade 2 on the mMFS and grade 3 on the SPS. T2- and enhanced T1-weighted MRI of the thoracic spine revealed an intradural tumor at the Th2/3 level with severe compression of the spinal cord [Figure 6a-c]. Simpson grade 1 resection of the tumor was accomplished. Pathological examination verified the diagnosis of fibrous meningioma. The patient demonstrated gradual improvement of neurological function early after surgery. T2- and enhanced T1-weighted MRI obtained postoperatively showed complete removal of the tumor [Figure 6d]. Assessment of the neurological condition at the most recent follow-up suggested grade 1 on the mMFS and grade 2 on the SPS. Supplemental digital content of surgical video Patient 6 was provided.

DISCUSSION

Although spinal meningioma generally responds favorably to surgical excision, tumor recurrence after incomplete resection is not uncommon.[2-5,21,22] In cases of recurrence, the integrity of the arachnoid membrane is usually compromised, and the tumor may invade the pial membrane of the spinal cord. The dissection plane between the spinal cord and recurrent tumor is not clear, resulting in a high-risk of surgical morbidity. Consequently, complete resection of the tumor at primary surgery is of great importance to achieve satisfactory or acceptable outcomes in the long-term after surgery. Factors leading to recurrence after surgery have been discussed by various authors, and are considered to include young patient age, subtotal or partial resection of the

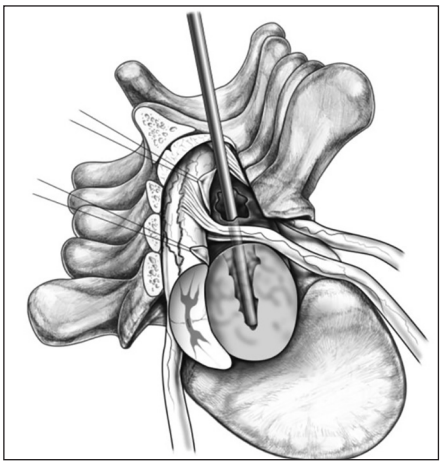

Figure 4: Schematic drawings demonstrating the basic concept of the surgical technique

Figure 5: Case 2: (a-c) Preoperative T2- and enhanced T1-weighted magnetic resonance imaging of the cervical spine show an intradural tumor at the C2/3 level with severe compression of the spinal cord. (d) Postoperative T2-weighted magnetic resonance imaging shows complete removal of the tumor

Figure 6: Case 6: (a-c) Preoperative T2- and enhanced T1-weighted magnetic resonance imaging of the cervical spine show intradural tumor at the Th2/3 level with severe compression of the spinal cord. (d) Postoperative T2-weighted magnetic resonance imaging shows complete removal of the tumor

lesion, calcification, extradural attachment, multiplicity of lesions, and ventral attachment.[1-9] Previous reports have suggested high rates of tumor recurrence in patients younger than 50 years at the time of surgery and in patients followed-up for long periods even after Simpson grade 2 resection. Cohen-Gadol *et al.* reviewed data obtained in a cohort of 40 patients >50 years of age with histologically confirmed spinal meningioma,[2] and compared these data with those derived from a control cohort of 40 patients over 50 years old in whom resection of spinal meningioma was performed over the same period. They reported a recurrence rate of 22% (9 of 40 patients) in the younger patient group as compared with 5% (2 of 40 patients) in the older control group, highlighting the aggressive nature of these benign neoplasms in younger patients. Nakamura *et al.* reported that 6 of their 19 cases (31.6%) who underwent Simpson grade 2 resection required reoperation due to tumor recurrence with exacerbated neurological symptoms; however, none of the 43 patients treated by Simpson grade 1 resection experienced tumor recurrence.[8] Although, King *et al.* reported surgical results for 78 spinal meningioma cases operated on over a period of 20 years in a single neurosurgical unit.[5] They encountered only one case of recurrence, 14 years after the original surgery, and concluded that excision of the dural attachment of a tumor was unnecessary to achieve a low recurrence rate. It may be true that partial resection or unsatisfactory coagulation of the dural attachment is not sufficient to achieve better outcomes long after surgery. Meticulous and extensive coagulation of the dural attachment, as in Simpson grade 2 resections may be acceptable for most patients. However, complete resection of the dural attachment, as in Simpson grade 1 resection, may be warranted for young patients.

Spinal meningioma with ventral attachment represents a challenging issue for neurosurgeons. Several technical modifications have been proposed to secure safe and precise tumor resection.[10-14] A predominantly posterior approach is used to resect ventral, intradural, extramedullary spinal meningiomas. Kim and Chung successfully removed 18 large ventral, intradural, and extramedullary tumors using the posterior approach (conventional laminectomy).[13] Angevine *et al.* stated that most intradural ventral spinal lesions can be treated with contemporary microsurgical techniques, achieving long-term control/cure with preservation of neurological function.[10] Although surgical modifications of the posterolateral or lateral approaches with the excision of the pedicles, part of the vertebral body, and wide laminectomy may offer an adequate surgical corridor to the ventral canal, spinal stability needs to be carefully considered with posterior spinal instrumentation. Kawahara *et al.* reported their surgical modification of recapping T-saw laminocostotransversoplasty for ventral meningiomas of the thoracic spine.[12] Their technique represents a modification of costotransversectomy and T-saw recapping laminoplasty for spinal canal surgery, and it provides satisfactory exposure of the ventral canal. Although good reconstruction of the posterior thoracic elements is achieved, the patient needs to wear a hard thoracolumbopelvic orthosis for 3 months after surgery. An alternative approach may be the anterior transthoracic approach or lateral extrapleural approach.[11,14] Such anterior or lateral approaches may be technically demanding for safe surgery; but, the anterior transthoracic approach also requires violation of the pleural space and manipulation of the lungs and mediastinal structures, and it necessitates vertebrectomy.

CONCLUSIONS

Although spinal meningioma generally responds favorably to surgical excision, complete resection of the tumor at primary surgery is of great importance in achieving satisfactory or acceptable outcomes in the long-term after surgery. Spinal meningioma with ventral attachment is one of the challenging issues for spine surgeons. Our surgical technique using a lateral oblique position for the patient, laminectomy with unilateral medial facetectomy on the tumor side, and spinal cord rotation with the dentate ligament is not so technically demanding, and it can offer a posterolateral surgical corridor to the ventral canal of both the cervical and thoracic spine. It enables the surgeon to take a relatively narrow but direct surgical corridor to the ventral canal. The preliminary analysis undertaken in the present study suggests that functional outcomes were acceptable with minimal surgery-related complications, although considerable surgical experience is mandatory to achieve suitably high levels of surgical confidence.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Arima H, Takami T, Yamagata T, Naito K, Abe J, Shimokawa N, *et al.* Surgical management of spinal meningiomas: A retrospective case analysis based on preoperative surgical grade. Surg Neurol Int 2014;5 Suppl 7:S333-8.
2. Cohen-Gadol AA, Zikel OM, Koch CA, Scheithauer BW, Krauss WE. Spinal meningiomas in patients younger than 50 years of age: A 21-year experience. J Neurosurg 2003;98 3 Suppl:258-63.
3. Gezen F, Kahraman S, Canakci Z, Bedük A. Review of 36 cases of spinal cord meningioma. Spine (Phila Pa 1976) 2000;25:727-31.
4. Gottfried ON, Gluf W, Quinones-Hinojosa A, Kan P, Schmidt MH. Spinal meningiomas: Surgical management and outcome. Neurosurg Focus 2003;14:e2.
5. King AT, Sharr MM, Gullan RW, Bartlett JR. Spinal meningiomas: A 20-year review. Br J Neurosurg 1998;12:521-6.
6. Klekamp J, Samii M. Surgical results for spinal meningiomas. Surg Neurol 1999;52:552-62.
7. Mirimanoff RO, Dosoretz DE, Linggood RM, Ojemann RG, Martuza RL. Meningioma: Analysis of recurrence and progression following neurosurgical resection. J Neurosurg 1985;62:18-24.
8. Nakamura M, Tsuji O, Fujiyoshi K, Hosogane N, Watanabe K, Tsuji T, *et al.* Long-term surgical outcomes of spinal meningiomas. Spine (Phila Pa 1976) 2012;37:E617-23.
9. Roux FX, Nataf F, Pinaudeau M, Borne G, Devaux B, Meder JF. Intraspinal meningiomas: Review of 54 cases with discussion of poor prognosis factors and modern therapeutic management. Surg Neurol 1996;46:458-63.

10. Angevine PD, Kellner C, Haque RM, McCormick PC. Surgical management of ventral intradural spinal lesions. J Neurosurg Spine 2011;15:28-37.
11. Jenny B, Rilliet B, May D, Pizzolato GP. Transthoracic transvertebral approach for resection of an anteriorly located, calcified meningioma. Case report. Neurochirurgie 2002;48:49-52.
12. Kawahara N, Tomita K, Abdel-Wanis ME, Fujita T, Murakami H, Demura S. Recapping T-saw laminocostotransversoplasty for ventral meningiomas in the thoracic region. J Orthop Sci 2009;14:548-55.
13. Kim CH, Chung CK. Surgical outcome of a posterior approach for large ventral intradural extramedullary spinal cord tumors. Spine (Phila Pa 1976) 2011;36:E531-7.
14. Steck JC, Dietze DD, Fessler RG. Posterolateral approach to intradural extramedullary thoracic tumors. J Neurosurg 1994;81:202-5.
15. McCormick PC, Torres R, Post KD, Stein BM. Intramedullary ependymoma of the spinal cord. J Neurosurg 1990;72:523-32.
16. Takami T, Yamagata T, Mitsuhashi Y, Hayasaki K, Ohata K. Direct surgery for spinal arteriovenous fistulas of the filum terminale with intraoperative image guidance. Spine (Phila Pa 1976) 2012;37:E1524-8.
17. Takami T, Yamagata T, Naito K, Arima H, Ohata K. Intraoperative assessment of spinal vascular flow in the surgery of spinal intramedullary tumors using indocyanine green videoangiography. Surg Neurol Int 2013;4:135.
18. Takami T, Yamagata T, Ohata K. Posterolateral sulcus approach for spinal intramedullary tumor of lateral location: Technical note. Neurol Med Chir (Tokyo) 2013;53:920-7.
19. Simpson D. The recurrence of intracranial meningiomas after surgical treatment. J Neurol Neurosurg Psychiatry 1957;20:22-39.
20. Takami T, Naito K, Yamagata T, Ohata K. Surgical management of spinal intramedullary tumors: Radical and safe strategy for benign tumors. Neurol Med Chir (Tokyo) 2015;55:317-27.
21. Nadkarni B, Arora A, Kumar S, Bhatia A. Recurrent spinal meningioma: A case report with review of the literature. J Orthop Surg (Hong Kong) 2005;13:326-9.
22. Tsuda K, Akutsu H, Yamamoto T, Nakai K, Ishikawa E, Matsumura A. Is Simpson grade I removal necessary in all cases of spinal meningioma? Assessment of postoperative recurrence during long-term follow-up. Neurol Med Chir (Tokyo) 2014;54:907-13.