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Surgical Outcome of Spinal Canal Meningiomas

Objective : We report experiences and clinical outcomes of 61 cases with spinal canal meningiomas from January 1970 through January 2005.

Methods : Thirty-eight patients were enrolled with follow-up duration of more than one year after surgery. There were 7 male and 31 female patients. The mean age was 52 years (range, 19 to 80 years). All patients underwent microsurgical resection using a posterior approach.

Results : Twenty-nine (79.4%) cases experienced clinical improvement after surgery. The extent of tumor resection at the first operation was Simpson Grade I in 10 patients, Grade II in 17, Grade III in 4, Grade IV in 6, and unknown in one. We did not experience recurrent cases with Simpson grade I, II, or III resection. There were 6 recurrent cases, consisting of 5 cases with an extent of Simpson grade IV and one with an unknown extent. The mean duration of recurrence was 100 months after surgery. Radiation therapy was administered as a surgical adjunct in four patients (10.5%). Two cases were recurrent lesions that could not be completely resected. The other two cases were malignant meningiomas. No immediate postoperative death occurred in the patient group.

Conclusion : We experienced no recurrent cases of intraspinal meningiomas once gross total resection has been achieved, regardless of the control of the dural origin. Surgeons do not have to take the risk of causing complication to the control dural origin after achieving gross total resectioning of spinal canal meningioma.

KEY WORDS : Spinal canal · Meningioma · Extent of resection · Recurrence · Control · Dural origin.

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INTRODUCTION

Intraspinal meningiomas represent the second most common tumor, following schwannomas, and account for about 25-46% of all spinal canal tumors²⁰. They arise in any age group, but the majority of them occur in individuals between the fifth and seventh decades of life. Early diagnosis and treatment produce excellent results in general. As stated by Cushing and Eisenhardt⁴, "a successful operation for a spinal meningioma represents one of the most gratifying of all operative procedures," and the goal of treatment should be complete surgical resection. The surgical prognosis of intraspinal meningiomas has dramatically improved with the development of neuroimaging and microsurgical techniques and monitoring instruments. Total resection of a spinal canal meningioma usually is not difficult, but if the tumor is ventral to the cord and calcified, surgery becomes hazardous and may damage the cord⁷. The extent of the resection is the most important factor determining the recurrence rate in all of the intracranial and intraspinal meningiomas⁵. The purpose of this review is to present clinical outcomes of 38 cases with spinal canal meningioma.

MATERIALS AND METHODS

We retrospectively analyzed the clinical presentations and outcomes of 61 patients who were consecutively operated on between January 1970 and January 2005 for spinal canal meningioma. Among them, 31 women (81.6%) and 7 men (18.4%) were enrolled, with a mean duration of follow-up of more than 1 year after surgery. The other 23 cases were not available for assessment of clinical results after operation due to lost from follow-up. No cases of foramen magnum meningioma were included in the review. The mean age was 52 years (range, 19 to 80 years).

At the time of diagnosis, the most common symptom presented was paraparesis (in 21 patients, 55.3%). The pattern of progression of clinical symptoms was directly related to

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the location of the tumor. All of the patients were followed-up postoperatively for 73 months on average (range, 16 to 223 months).

Neuroradiologic diagnoses of the tumors were made by myelogram (six cases) or magnetic resonance imaging (MRI) (32 cases). A routine plain radiograph was obtained in all cases. Most of the operations were performed using a microsurgical technique and, when necessary, a surgical aspirator (Cavitron Ultrasonic Surgical Aspirator) was also applied. All surgeries were performed through a posterior approach. After radical removal of the tumor, the resection of the involved dura or the coagulation of dural attachment of the tumor was performed as often possible. The dura was closed in most of the patients with dural defects repaired using lyophilized dura.

RESULTS

Tumor locations

The locations of spinal canal meningiomas were cervical in six patients (15.8%), the cervicothoracic junction in two (5.3%), thoracic in 28 (73.7%), lumbar in one (2.6%), and a low thoracolumbar location in one (2.6%). Intraoperatively, we found two cases located in the epidural space, 34 cases in the intradural space, and two cases in intra- and extradural space. Tumor position was laterally in 12 cases (32%), posterolaterally in ten cases (10%), posteriorly in one (3%) and anteriorly in five (13%). Ten cases were not applicable.

There was no correlation between tumor position and prognosis.

Surgical results

All of 38 patients underwent microsurgical exploration with an attempted gross total resection (achieved in 32 patients, 84.2%) and subtotal resection or partial resection (achieved in six patients, 15.8%) of the meningiomas using a posterior approach in our hospital or other. The extent of the

tumor resection at the first operation was Simpson Grade I in ten patients, Grade II in 17, Grade III in four, Grade IV in six, and unknown in one. The extent of resection was not recorded for one patient because the resection had been performed at other hospital.

Paraparesis was the predominant motor symptom in 21 patients (55.3%), and hypesthesia was the predominant sensory symptom in 26 patients (68.5%). Bladder and sphincter disturbances were found in 11 patients (28.9%). The mean duration of the development of symptoms prior to surgery was 12 months. Surgical resection led to significant alleviation of pre-operative symptoms. Surgical results showed improvement in 30 cases (78.9%), no change in six cases (15.8%), and deterioration in two cases (5.3%) due to the surgery induced spinal cord injury and syrinx formation.

There was no radiographic evidence of tumor recurrence in patients with an extent of resection of Simpson grade I, II, or III. We experienced six recurrences that consisted of five cases with an extent of Simpson grade IV and one with an unknown extent. Five recurrence cases underwent one additional operation, and one case proven to be malignant meningioma underwent two additional operations. The mean duration of recurrence was 100 months (range, 12 to 204 months) after surgery. After the second operation, it was decided that irradiation of the remnants would be conducted for two cases, and the site of origin site was proven to be malignant meningioma in another two cases.

Table 1. Summary of final outcomes of spinal meningiomas with the extent of Simpson grade I, II and III and with an unknown extent after initial surgery (N= 32)

Initial resection	No. of cases	Surgical outcome and No. of case	Follow-up period (month)	Comments
Simpson Gr I	10	10, ND*	71	-
Simpson Gr II	17	16, ND	58	-
		1, PD†	36	Final outcome : death, Pathology : Malignant MNG [†] with intracranial malignant MNG, RTx : 4050 cGy at T10-L2
Simpson Gr III	4	4, ND	95	-
Unknown	1	1, PD	22	Final outcome : ND for 28 month after reoperation (Simpson Gr II)

* ND : No evidence of disease, † PD : Progressive disease, ‡ MNG : Meningioma

Table 2. Summary of final outcomes of spinal meningiomas with the extent of Simpson grade IV after initial surgery (N=6)

Case No.	Initial surgical outcome	Duration of regrowth (month)	Extent of reoperation	Adjuvant RTx	Position related to cord	Final outcome	Follow-up after last op (month)	Comments
1	PD [†]	156	Simpson IV	Y	Lateral	SD [‡]	47	-
2	PD	12	Simpson III	N	Lateral	ND*	180	-
3	PD	13	Simpson II	Y	NA [§]	Death	12	Malignant MNG
4	PD	204	Simpson IV	Y	Lateral	SD	16	-
5	PD	20	Simpson IV	N	NA	SD	80	-
6	SD		Observation	N	dorsolateral	SD	18	-

* ND : No evidence of disease, † SD : Stable disease, ‡ PD : Progressive disease, § NA : not available, || MNG : Meningioma

The surgical outcomes and recurrences are summarized in Tables 1 and 2.

Radiation therapy was given as a surgical adjunct in four patients (10.5%). The remnants in two benign patients were irradiated because we concluded that they could not have been reoperated more owing to severe adhesion if it would recur again. Two other cases were proven to be malignant meningiomas.

There were two cases of postoperative CSF leakage and two cases of worsened neurological status due to surgery-induced spinal cord trauma and syrinx formation. No immediate postoperative death occurred in the present series. Two patients died of progression of malignant meningioma.

Histopathological characteristics

The histological type was psammomatous in seven (18.4%), fibrous in four (10.5%), meningothelial in 16 (42.1%), transitional in five (13.2%), mixed type in four (10.5%), and malignant meningioma in two patients (5.3%).

Miscellaneous

We experienced one neurofibromatosis-1 (NF-1)- and one neurofibromatosis-2 (NF-2)-associated case, respectively. There were two intraspinal cases associated with intracranial meningioma. One patient underwent craniotomy with transitional type meningioma in the right temporal base. Another patient underwent craniotomy and radiotherapy with malignant meningioma in the petroclival area. Two benign meningioma cases associated with other malignancies, which were diagnosed as non-Hodgkins lymphoma and lung cancer, were experienced.

DISCUSSION

The annual incidence of primary intraspinal neoplasm is about 5/1,000,000 for females and 3/1,000,000 for males¹⁸. Spinal intradural extramedullary tumors account for two-thirds of all intraspinal neoplasms, and include neuromas and meningiomas¹.

Spinal canal meningioma is a benign lesion that commonly occurs in women of middle age. It accounts for approximately 25-46% of spinal tumors^{12-15,20}.

Many investigators have reported a higher proportion of women in their series^{1,12-15}. In the recent series, the female-to-male ratios in patients with spinal meningioma ranged from 3 and 4.2 to 1, and the ages of the people who were affected ranged mostly from 40 to 70 years. In our series, the female-to-male ratio is 4.3 to 1, and women are overrepresented compared with recent series. It has been suggested that spinal meningioma occurs more frequently in fertile women because

of the possible dependency of these tumors on sex steroid hormones^{15,20}. Although the theory on the effect of hormones on meningioma is controversial, hormonal studies have shown the existence of various receptor types (peptidergic, growth factor, steroid, and aminergic) that may contribute to meningioma formation¹⁵.

In the current series, 73.7% of tumors were located in the thoracic region. The incidence of thoracic location was reported to be 75% by Levy et al.¹², 66% by Namer et al.¹⁴, and 79.5% by Roux et al.¹⁸. They occurred far less frequently in the cervical region (14-27%), and rarely in the lumbar region (2-14%)⁹.

Spinal cord meningiomas, like meningiomas elsewhere⁵⁻⁷, grow from intradural attachments, then stretch the arachnoid over them, sometimes incorporating the arachnoid, but rarely the pia. Extradural meningiomas without an intradural component are exceedingly rare¹⁸. Spinal canal meningioma arises from cap cells of the arachnoid membrane and originate in proximity to nerve roots^{12,15}.

Pain is the most common symptom in the recent series^{1,3,12,17,18,20}. Paraparesis was the predominant symptom (54.1%) in our series. It has usually been confused because the neurological impairment of spinal canal meningiomas is very similar to that seen in degenerative spinal disorder, herniated disc disease, and other diseases such as syringomyelia, multiple sclerosis, and others.

Before the era of MRI, intraspinal meningioma could be diagnosed preoperatively with myelography or computed tomography scan. Since its introduction, MRI has been determined to be the best noninvasive neuroimaging technique in achieving exact diagnosis. The MRI findings that make it possible to distinguish benign from malignant tumors mainly include parameters such as tumor outline, invasive behavior, and edematous reactions. Spinal meningioma usually showed strong enhancement with a broad dural base on MRI studies after intravenous injection of gadolinium-DTPA.

In most cases, meningioma growth is slow and well-distinguished from the spinal cord, enabling easy removal of the tumor^{3,12-15,17,18,20}. Total resection of the tumor was achieved in most of the cases (84.2%) in this study. The rate of total tumor resection was reported to be 82% by Levy et al.¹², 92.6% by Roux et al.¹⁸, and 97% by Solero et al.²⁰ Tumors carry a favorable prognosis if completely resected. However, radical surgery may result in higher morbidity. This is particularly true for anteriorly located and en plaque meningiomas for tumors located in the thoracic spine due to the peculiar configurations of feeding vessels and in the presence of intratumoral calcifications^{8,11,18,21}.

There were some technical difficulties of tumor resectioning,

especially because of the ventral location to the cord, although even in those cases, resectioning of the tumor can be performed using a careful microsurgical technique. Recent neuroradiological and neurosurgical technical developments resulted in the improvement of surgical results of spinal tumors. The postoperative results varied according to preoperative neurological status, the nature and location of the tumor, and the type of surgical resection. No immediate postoperative death occurred in the current series. Although the extent of resection is thought to be the main prognostic factor in the treatment of benign tumors, there has been no convincing data to show any clear relationships between recurrence rates, the location of the tumor, and the extent of resectioning in spinal meningioma. Recurrence of spinal meningiomas often results in higher morbidity compared to intracranial cases^{10,20}.

Well-recognized histologic meningioma types include the meningotheliomatous, fibroblastic, transitional, psammomatous, and angiomatous tumors. The recurrence rate of intracranial meningioma is approximately 10-20%, depending on the length of follow-up. Metastases are rarely seen^{13,15}. Only a few long-term studies of spinal meningioma including the rate of late recurrence have been reported to date. The late recurrence rate was reported to be 4% by Levy et al.¹² and 1.3% by Solero et al.²⁰ Mirimanoff et al.¹³, reported that, after a total resection, the recurrence-free rates at 5, 10, and 15 years, were 93%, 80% and 68%, respectively, whereas, after a subtotal resection, the progression-free rates were only 63%, 45% and 9%, respectively, during the same periods. Excision of the dural margin, in contrast to simply cauterizing the margins, is associated with a lower recurrence rate (4-8% for dural margin cauterization and 0-5.6% for dural margin excision)^{12,18}. In the current series, we experienced six recurrence cases but we did not experience any recurrent cases with Simpson grade I, II, or III at the first operation (Table 1). Six patients showed recurrence at 12, 13, 20, 156, 192, and 204 months after surgery. Five of all recurrences occurred in patients who had undergone subtotal resection (Simpson grade IV) (Table 2). Like the authors of other studies^{2,16,19}, we believe that spinal meningiomas have such a low rate of recurrence because of both their poor tendencies for growth (they are mostly psammomatous calcifying tumors; only 18.4% in the present series) and their prevalence in an aged population in whom the follow-up period is relatively short.

Although the acceptable treatment method for spinal meningioma is total removal of the tumor by microsurgery, Mirimanoff et al.¹³ suggested that radiotherapy should be considered as an adjunctive treatment after subtotal excision. Radiotherapy can also control unexcised or recurrent menin-

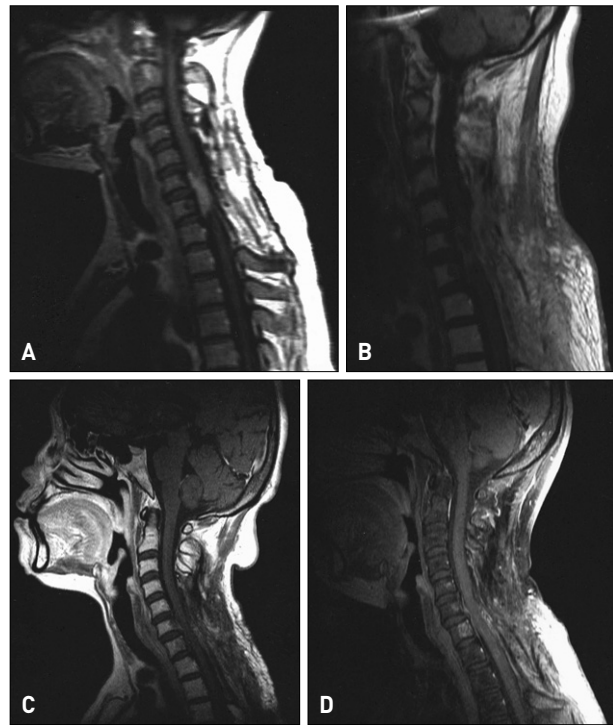


Fig. 1. Magnetic resonance images (MRI) in a 32-year-old woman with quadriplegia. Preoperative MRI was not applicable. The patient complained of newly developed radiating pain in her left arm 13 years after the initial operation. A : Sagittal T1-weighted cervicothoracic MRI with gadolinium enhancement 2 months before reoperation surgery shows a well-enhanced intradural extramedullary recurrent residual mass. B : Cervicothoracic MRI shows a residual mass lesion 3 months after the second operation. C : MRI demonstrates no interval change of mass size 6 months after radiation. Follow-up MRI was performed three years after reoperation. D : Four years after the second operation, MRI demonstrates no interval change of mass size.

gioma. We decided that radiotherapy should be administered to four cases; two malignant meningiomas and two recurrent cases of a benign histologic type with a Simpson IV extent of resection at the second operation (Fig. 1). As mentioned above, although the policy of irradiation to intraspinal meningioma is that we reserve irradiation as possible as we can in case of benign histology in our hospital, the remnants in two benign patients were irradiated because we concluded that they could not have been reoperated more owing to severe adhesion if it would recur again. The role of radiotherapy in the treatment of spinal meningioma remains controversial because of the indolent nature of the disease and potential damage caused by radiation.

CONCLUSION

In this report, the surgical outcome of 38 cases of spinal canal meningioma have been reviewed. Surgical removal of spinal canal meningioma improved clinical symptoms and signs. Recently, advances in microneurosurgery and

neuroimaging techniques have resulted in decreases in mortality and morbidity rates of spinal meningioma. Early detection and complete resectioning of spinal canal meningiomas seem to produce a good clinical outcome. It is well-known that the recurrence rate of intracranial meningiomas is correlated with the extent of resection. Our patients experienced no recurrence of intraspinal meningiomas once gross total resectioning was achieved, regardless of the control of the dural origin. Surgeons do not have to risk causing complications in attempts to control the dural origin after achieving gross total resection of spinal canal meningioma.

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COMMENTARY

The authors have retrospectively analyzed 38 patients who underwent operations for spinal canal meningiomas with follow-up duration of more than 1 year to assess the factors associated with the surgical outcome after operation. The surgical result was analyzed by clinical symptoms and Simpson grade. The authors focused on the extent of tumor resection, recurrence, and radiation therapy.

They found no recurrence of intraspinal meningioma once gross total resectioning was achieved, regardless of the control of the dural origin. The authors performed radiation therapy in 2 cases of remnant group and in 2 cases of malignant group. I agree with the use of radiotherapy in case of recurrent inoperable meningioma, but I think that the acceptable treatment method for spinal meningiomas is total removal of the tumor. If total removal cannot be considered, radiotherapy should be considered as an alternative approach.

Recently, reoperation with advanced microsurgical technique without radiotherapy is strongly recommended in recurrent cases by some authors. Additionally, I recommend unilateral hemilaminectomy microsurgical approach in the case of adequate criteria of spinal intradural extramedullary tumor such as meningiomas or schwannomas.

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