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Results of spinal meningioma surgery in patients with severe preoperative neurological deficits

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Abstract Spinal meningiomas are usually benign, slow-growing tumours and are commonly associated with good patient outcome following surgery. However, the existence of a severe preoperative neurological deficit has been considered to be a possible predictor of poor functional outcome after surgery. We retrospectively reviewed data from 33 patients with 35 spinal meningiomas treated in our institution over the past 17 years and exhibiting severe preoperative deficits before surgery. Among them, 20 suffered from paraparesis and 13 were paraplegic. The mean follow-up duration was

70.7 months (range 12–183 months). By the 1-year follow-up, all patients had improved in comparison with their preoperative neurological status, and 60% of them had totally recovered. It can be concluded from this study, that, in the vast majority of cases, patients harbouring spinal meningioma with severe preoperative deficits can expect a good outcome.

Keywords Paraplegia · Prognosis · Spinal meningiomas · Spinal neoplasms · Spinal surgery

Introduction

Spinal meningiomas are usually well-circumscribed, slow-growing tumours and account for 25% of all primary spinal neoplasms [20]. Technological advances in neuroimaging, anaesthesiology and microsurgery, together with appropriate rehabilitation have all helped to improve surgery-related outcomes. Nevertheless, certain significant prognostic factors associated with a poor outcome have been suggested and these include, in particular, profound preoperative neurological deficits [1, 2, 4, 10, 19, 23]. As is generally acknowledged with nervous tissue injuries, the axiom “the milder the neurological deficit, the better the functional outcome” would appear to be relevant here. Furthermore, some authors have stated that associated factors, such as duration of the neurological deficit and advanced age, influenced both the speed and level of recovery after surgery [2, 23]. We conducted a retrospective study to

evaluate the clinical outcome in 33 patients with spinal meningiomas suffering from severe preoperative neurological deficits.

Materials and methods

Eighty-two patients with 84 histologically confirmed spinal meningiomas were operated on in our Neurosurgical Department between 1986 and early 2003. Of these patients, 33 (40%) with 35 spinal meningiomas suffered from severe preoperative neurological deficits and were rated grade III (60.6%, $n=20$) or IV (39.4%, $n=13$) by Levy score [16] (Table 1). We retrospectively reviewed gender, age, duration of symptoms before diagnosis, spinal location and anterior–posterior distribution of meningiomas, postoperative Levy score, morbidity and mortality. The outcome was considered to be a total recovery if the recovery rate was 100%.

Table 1 Classification of neurological disability according to Levy score

Classification	Symptoms and signs
Grade 0	Normal
Grade I	Walking with assistance
Grade II	Strength greater than gravity
Grade III	Strength less than gravity
Grade IV	Paraplegic (no motor response)

All the patients underwent a postoperative follow-up at 12 months and a long-term follow-up 12–183 months after the operation, with a mean of 70.7 months. Statistical analysis was performed using SPSS 10.0 software (SPSS, Chicago, IL, USA). The χ -square and t tests were used to assess the prognostic value of preoperative features. Multivariate analysis was performed with logistic regression. The level of significance was set to 0.05.

Results

The patients' data are summarised in Tables 2 and 3.

The patients ranged from 14 to 88 years of age (mean age, 66.3 years) with two thirds of them aged above 65. There was a predominance of females (84.8%) with a female to male ratio of 5.6:1. The mean duration of symptoms until surgery was 13.7 months (range, 1–120 months). Eighty percent ($n=28$) of all meningiomas were located in the thoracic spine, 17.2% ($n=6$) in the cervical spine and 2.8% ($n=1$) in the lumbar spine. One case was located extradurally and another case was found in an intra-extradural location, whereas the other meningiomas were strictly intradural. Meningiomas were lateral to the spinal cord in eight cases, anterior or anterolateral in 11 cases and posterior or posterolateral in 16 cases. Two meningiomas were *en plaque*.

All patients were operated on in the prone position via a posterior approach using laminectomy and with the aid of an operating microscope. Complete tumour removal was achieved in 33 meningiomas (94.3%) and subtotal removal was performed on two meningiomas (5.7%). The dural attachment was totally removed in two meningiomas and coagulated in the remaining tumours. The dura was closed in all patients and when necessary, dural defects were repaired with aponeurotic fascia.

Operative morbidity and mortality

There was no operative mortality. One patient exhibited postoperative phlebitis, and one patient suffered from a pulmonary infection.

Postoperative functional outcome

At the 12-month follow-up, all patients had improved in comparison with their preoperative neurological status. Nineteen patients (57.6%) totally recovered, ten (30.3%) were grade I, three (9.1%) were grade II, and one (3%) patient was grade III. Preoperative Levy score, duration of symptoms, age, gender, and axial and craniocaudal location of meningioma were not statistically related to the postoperative functional outcome. Five patients died of causes unrelated to surgery over the entire follow-up period. Neither recurrence nor late deterioration was observed during the follow-up period.

Discussion

In the medical literature, spinal meningiomas predominantly occur in females (gender ratio, 4:1) and the patients' mean age is between 49 and 62 years at the time of diagnosis [1, 6, 9, 13, 15, 16, 18, 19, 22, 23]. A slow progressive myelopathy is the most common mode of presentation. The mean duration of symptoms is 14 months (ranging from 1.5 months to 5 years) prior to diagnosis but sudden onsets have been reported, generally associated with falls [16]. Meningiomas are more frequently located in the thoracic segment of the spine and mostly involve the lateral intradural extramedullary compartment of the vertebral canal. In the current series, demographic, clinical and anatomical data are close to those previously reported in the pertinent literature, except for the high incidence of elderly patients (aged 65 years and above). This may be explained by the increased life expectancy in Western countries and the relatively recent study period, in comparison with previous reports [1, 4, 10, 19, 22]. Generally, advanced age is considered to be a predictor of poor outcome after spinal meningioma surgery [2, 23]. In a series reported by Ciappetta et al. [2], the mean age of patients was 57 years (range, 33 to 73 years), and they observed that both the speed of recovery and the final recovery rate were lower in patients over the age of 60. Their conclusions correspond to what every sensible surgeon would intuitively predict: the better the general preoperative condition, the better the outcome. Moreover, it is a generally admitted rule that operative procedures in the elderly are associated with higher morbidity and mortality, compared with similar operations performed on younger individuals [5, 17]. In our series, which included a high ratio of elderly patients (2:3), the absence of mortality, the low rate of morbidity and the good functional outcome could be attributed to several factors: a small number of patients, the good general health and condition of most of the patients, advances in neuroanaesthesia, early mobilisation and rehabilitation

Table 2 Thirty-three patients affected by spinal meningiomas with severe preoperative neurological deficits. Recovery points = (preoperative Levy score) – (postoperative Levy score)

Case no.	Age (years)	Sex	Duration of symptoms before surgery (months)	Location	Surgical removal	Levy score		Follow-up (months)	Recovery points
						Preoperative	Postoperative		
1	73	F	1	T7	Total	III	Total recovery	72	3
2	67	F	8	C7–T1	Total	IV	II	12	2
3	64	F	3	T10	Total	IV	III	15	1
4	79	M	12	T5	Total	IV	I	156	3
5	81	M	16	T11	Total	III	Total recovery	183	3
6	74	F	2	T5	Total	IV	Total recovery	36	4
7	19	F	4	C6–T1	Total	III	Total recovery	151	3
8	88	F	12	T5–T6 + T8–T9	Total	IV	I	31	3
9	69	F	9	T9 + T11–T12	Total	III	I	84	2
10	67	F	3	C7–T2	Total	III	I	12	2
11	57	F	13	C7–T1	Total	III	Total recovery	140	3
12	70	F	3	T8–T9	Total	III	I	136	2
13	73	F	12	C8	Total	IV	Total recovery	54	4
14	79	F	12	T8–T9	Total	IV	I	142	3
15	76	F	72	T4–T5	Total	IV	I	131	3
16	80	F	15	T10–T11	Total	IV	Total recovery	60	4
17	14	F	6	T8	Total	III	Total recovery	127	3
18	86	F	6	T7	Subtotal	IV	Total recovery	12	4
19	22	M	5	C6–C7	Total	IV	Total recovery	121	4
20	64	F	120	C5–C6	Total	III	Total recovery	117	3
21	75	F	3	T3–T4	Total	III	Total recovery	62	3
22	69	F	2	T6–T7	Total	III	I	63	2
23	80	F	6	T5	Subtotal	IV	Total recovery	12	4
24	61	M	6	T2–T3	Total	III	Total recovery	60	3
25	76	F	7	T11–T12	Total	III	Total recovery	64	3
26	64	F	11	T12	Total	III	Total recovery	51	3
27	49	M	5	L1–L2	Total	III	II	51	1
28	70	F	2	T6–T7	Total	IV	I	48	3
29	58	F	13	T8–T9	Total	III	Total recovery	40	3
30	64	F	12	T6–T7	Total	III	Total recovery	40	3
31	66	F	24	T11	Total	III	Total recovery	19	3
32	71	F	3	T8–T9	Total	III	I	17	2
33	85	F	24	T6–T7	Total	III	II	16	1
Mean	66.3		13.7					70.7	
Median	70		7					60	
Minimum	14		1					12	
Maximum	88		120					183	

and careful surveillance for complications such as deep vein thrombosis and pulmonary infections.

From our patients with spinal meningioma, we selected those suffering from severe preoperative neurological deficits. By 12 months, all of them had improved thanks to surgical procedures. Previous reports considered profound preoperative neurological deficits to be detrimental to recovery [1, 2, 4, 10, 19, 23]. In 1988, Ciappetta et al. [2] specifically reported on the clinical outcome following spinal meningioma surgery in

22 patients with severe preoperative motor deficits. Although the functional outcome of their patients with severe paraparesis was relatively favourable, those suffering from paraplegia had a poor outcome. On the other hand, some authors have stressed that even paraplegic patients have a chance of recovering ambulation given time [16, 22]. Our series showed no statistically significant difference in recovery rate between patients rated grade III or grade IV preoperatively. Experimental studies have demonstrated that functional recovery after

Table 3 Correlation between preoperative and postoperative Levy scores of 33 patients with spinal meningiomas

Preoperative Levy score	Postoperative Levy score				Total
	Total recovery	I	II	III	
III	13 (65%)	5 (25%)	2 (10%)	–	20 (60.6%)
IV	6 (46.1%)	5 (38.5%)	1 (7.7%)	1 (7.7%)	13 (39.4%)
Total	19 (57.6%)	10 (30.3%)	3 (9.1%)	1 (3%)	33

acute balloon compression of the spinal cord depends on the magnitude of the compression force as well as its duration [25, 26]. Recent clinical studies have confirmed that in acute spinal cord compression, whatever the cause, prognosis for recovery depends mainly on two factors: the severity of the neurological deficit and the duration of the deficit before decompression [11]. Whether acute or chronic, spinal cord compression damages neural tissue both by mechanical and vascular mechanisms. Experimental subacute and chronic compressive myelopathy has shown that the first modification is impairment of somatosensory evoked potentials, which is attributable to a mechanical factor [7, 8, 12]. However, as the degree of compression increases, there is a rapid reduction of spinal cord blood flow leading to ischemia once the autoregulatory limits have been exceeded. Pathological examination revealed irreversible changes, including flattening of the anterior horn, disappearance and necrosis of anterior horn cells in the grey matter, and demyelination and axonal degeneration in the white matter [8, 12]. The mean duration of spinal cord compression in these animal studies was 10 months, which is close to the mean duration of symptoms before diagnosis in clinical reports on spinal meningiomas. According to these experimental studies, we should not expect such a recovery rate in patients with preoperative paraplegia. Meningiomas are usually slow-growing and well-delineated. These tumours exhibit benign biological behaviour and can therefore be assumed to exert a predominantly compressive action.

On the other hand, other local factors such as arachnoiditis can occur after surgery and could theoretically impede recovery. Spinal arachnoiditis is an almost

constant condition following spinal meningioma surgery [24]. We believe that arachnoid scarring is often asymptomatic but may, in some instances, decrease the chance of functional recovery by causing spinal cord tethering, impairment of spinal cord blood flow and obstruction of cerebrospinal fluid flow. As suggested by some authors [14, 15], arachnoid scarring can also cause secondary progressive neurological deterioration after spinal intradural surgery. It is well known that blood in the cerebrospinal fluid may produce an inflammatory response of the leptomeninges resulting in arachnoiditis. Recently, Sajanti and Majamaa [21] demonstrated that collagen synthesis markers become markedly increased in the cerebrospinal fluid following a subarachnoid haemorrhage, suggesting a fibroproliferative reaction or fibrosis. To minimise the risk of postsurgical spinal arachnoiditis, we recommend the systematic use of magnification to perform careful dissection of the arachnoidal sheath covering meningioma and meticulous haemostasis during meningioma removal.

As early as 1938, spinal meningioma surgery was described by Cushing and Eisenhardt [3] as being "one of the most gratifying of all operative procedures". Since then, large series have confirmed the usually favourable outcome following removal of these tumours but have also emphasised the importance of the preoperative neurological deficit as a predictor of a poor outcome. Through our experience with patients suffering from severe preoperative neurological deficits, we can conclude that a good functional outcome should be expected in the vast majority of cases, and that more than half of patients should recover totally after surgery.

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