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Clinical Article

Clinical Analysis of 21 Cases of Spinal Cord Ependymoma : Positive Clinical Results of Gross Total Resection

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Objective : To evaluate the clinical results of gross total resection in the surgical approach to spinal ependymoma.
Methods : Between June 1995 and May 2009, 13 males and 8 females (mean age 34) diagnosed with intramedullary or extramedullary spinal ependymoma were surgically treated at our centre. The neurological and functional state of each patient were evaluated according to the modified McCormick scale.
Results : The average follow-up duration was 54 months (ranging from 12 to 168 months). The locations of the lesions were : thoracic region (4, 19%), lumbar region (7, 34%), cervical region (4, 19%), cervicothoracic region (3, 14%) and conus medullaris (3, 14%). Four patients (19%) had deterioration of neurological function in the early postoperative period. The neurological function of three patients was completely recovered at the 6th postoperative month, while that of another patient was recovered at the 14th month. In the last assessment of neurological function, 20 patients (95%) were assessed as McCormick grade 1. No perioperative complications developed in any of our patients. In one patient's 24-month assessment, tumour recurrence was observed. Re-operation was not performed and the patient was taken under observation.
Conclusion : Two determinants of good clinical results after spinal ependymoma surgery are a gross total resection of the tumour and a good neurological condition before the operation. Although neurological deficits in the early postoperative period can develop as a result of gross total tumour resection, significant improvement is observed six months after the operation.

KEY WORDS : Ependymoma · Intramedullary ependymoma · Intramedullary tumour · Functional outcome.

INTRODUCTION

Ependymomas account for 15% of all spinal tumours[15,21]. Ependymomas are the most common intramedullary tumour in adults, and they account for 60% of intramedullary spinal cord tumours[7,13,15,18,21]. Both intramedullary and extramedullary ependymomas occur. Intramedullary ependymomas are most commonly observed in the cervical region; however, 40% of intradural ependymomas stem from the filum terminale and most of them are myxopapillary ependymomas[12,24]. Ependymomas that are observed in the filum terminale region are accepted as extramedullary tumours in terms of surgical approach and involvement area[22]. Almost all spinal cord ependymomas are histologically benign tumours[2,4,7,9,12]. Maximal resection of the tumour while protecting neurological function is the golden rule in surgical treatment of spinal ependymomas[1,2,4,9,11,12,14,15].

In this retrospective study, we reviewed clinical data regarding the pre- and post-operative neurological function of spinal ependymoma patients treated with gross total resection. We discuss the clinical results that were obtained from our patients during the follow-up period (an average 4.6 years), in which neither radiotherapy nor chemotherapy was applied.

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MATERIALS AND METHODS

A total of 21 adult patients (13 male and 8 female) with

ependymoma (either intramedullary or extramedullary) were surgically treated in the Istanbul American Hospital in the neurosurgery department between June 1995 and May 2009. Paediatric patients were excluded from the study. The mean patient age was 34 years. The neurological function of each patient was evaluated with a modified McCormick classification (Table 1)[11,12,20]. Patient functional assessments were done in the preoperative stage, the early postoperative stage, the postoperative 6th month and regularly every year.

Table 1. Modified McCormick Classification

Grade	Summary explanation
1	Neurologically normal, normal ambulation and professional activity, minimal dysesthesia
2	Mild motor and sensory deficit, independent function and ambulation maintained
3	Moderate sensorimotor deficit, restriction of function, independent with external aid
4	Severe sensorimotor deficit, restricted function, dependent
5	Paraplegia and quadriplegia, even/flickering movement

Magnetic resonance image (MRI) was utilised in the radiological follow-up of the patients. MRI evaluation was also used in the preoperative stage. MRI examinations were repeated in the early postoperative stage and six months postoperatively, and then for yearly follow-up evaluations.

The surgical treatments applied all used a posterior midline approach and included laminectomy, laminoplasty or hemilaminectomy. After the dura was opened, a dorsal midline myelotomy was performed on any intramedullary ependymomas and the intramedullary region was reached. When we reached the tumour tissue in the intramedullary region, cavitron ultrasonic surgical aspirator (CUSA) was used in all cases and the tumour tissue was completely resected. During the gross total resection of intramedullar ependymomas, neurophysiological monitoring was not used in every case. However, in ependymomas that were localised at the filum terminale, the tumour was en-bloc removed together with the filum terminale. All operations were carried out by two experienced senior neurosurgeons.

RESULTS

The patient follow-up period ranged from 12 months to 168 months, with an average duration of follow-up of 54 months. Four lesions were localised in the thoracic region (19%), 7 in the lumbar region (34%), 4 in the cervical region (19%), 3 in the cervicothoracic region (14%), and 3 in the conus medullaris (14%).

The most common preoperative symptoms or first clinical findings were : pain in 17 (81%) cases, sensory disorder in 5 (24%) cases, motor weakness in 5 (24%) cases, truncal ataxia and walking disorder in 2 (10%) cases, and respiratory distress in 1 (5%) case.

Gross total tumour resection was performed on all of our patients. In their pathological examinations, 7 (34%) lumbar region cases were identified as myxopapillary ependymomas stemming from the filum terminale, and 14 (66%) other cases were intramedullary ependymomas. There were no malignant ependymoma cases. None of our cases received adjuvant treatment such as radiotherapy in the postoperative period.

Among all total resection cases, four patients' (19%) neurological conditions showed deterioration in the early postoperative period. Three of the four patients were McCormick grade 1 in the preoperative period. The other patient was McCormick grade 2 in the preoperative period. Two of these patients deteriorated to McCormick grade 3 postoperatively, and the other two patients were postoperatively McCormick grade 2. The neurological function of three of the four patients had improved to preoperative levels (McCormick grade 1) at their 6-month assessment. One patient's postoperative neurological deficit, reduced to McCormick grade 2, remained so until the 14-month neurological examination, in which it was observed to have improved to McCormick grade 1. We thus determined that intraoperatively-acquired neurological deficits significantly improve within 6 months of the procedure.

In the final neurological function evaluations, all of our patients (with one exception, 5%) were assessed as McCormick grade 1 (95%). One patient was evaluated as McCormick grade 2, and this patient was surgically treated after being diagnosed with a T8-T10 thoracic intramedullary ependymoma. Preoperatively, the patient was assessed as McCormick grade 4. In the early postoperative period, the patient's neurological condition was evaluated as McCormick grade 3. At the 6- and 15-month postoperative neurological function evaluations, the patient was assessed as McCormick grade 2.

Patients who were assessed as McCormick grade 2 and above for neurological function were immediately placed in physiotherapy and rehabilitation programs in the early postoperative period. None of our patients developed perioperative complications. Tumour recurrence was observed in one (5%) patient in the 24th postoperative month. Since there was no deterioration in the patient's neurological condition, reoperation was not considered and the patient was monitored.

A summary of the patients' characteristics and outcomes is given in Table 2.

Table 2. Patients' characteristics

Patient No.	Age (yrs), sex	Clinical findings	Surgery	McCormick Classification				Follow-up (mo)	Level	Recurrence
				Preop-	Postop-early	Postop-month 6	Last			
1	32, F	Low back pain	GTR	1	1	1	1	12	L2-L4	None
2	17, F	Neck pain	GTR	1	3	2	1	14	C5-T1	None
3	27, M	Back pain	GTR	1	1	1	1	30	L2-L3	None
4	35, M	Back pain	GTR	1	1	1	1	21	L1-L2	None
5	48, M	Back pain	GTR	1	2	1	1	42	L1-L2	None
6	33, F	Quadriparetic, respiration uneasy	GTR	4	3	1	1	106	C2-C7	None
7	32, M	Quadriparetic	GTR	3	3	1	1	28	C5-6	None
8	35, F	Back and leg pain	GTR	2	2	1	1	116	L1-L5	None
9	25, M	Back pain	GTR	2	2	1	1	13	L4-S2	None
10	35, M	Back pain,	GTR	1	3	1	1	24	T10-T12	Available, under follow
11	31, M	Neck pain, quadriparetic	GTR	3	2	1	1	27	C7	None
12	32, M	Back pain	GTR	1	1	1	1	18	T3-T4	None
13	25, M	Leg dysesthesia	GTR	2	3	1	1	12	T1-T3	None
14	26, M	Back pain	GTR	1	1	1	1	42	L2-L3	None
15	32, M	Leg pain	GTR	1	1	1	1	62	L2-L3	None
16	43, F	Neck pain, arm dysesthesia	GTR	2	2	1	1	121	C6-T2	None
17	40, F	Paraparesia	GTR	4	3	2	2	15	T8-T10	None
18	37, F	Back pain	GTR	2	2	1	1	168	L2-L4	None
19	36, M	Back pain, paraparesia	GTR	3	2	1	1	162	T11-L2	None
20	57, M	Leg pain	GTR	1	1	1	1	49	L2-L3	None
21	36, F	Neck pain	GTR	1	1	1	1	55	C5-C7	None

GTR : gross-total resection

DISCUSSION

In this study we reported on spinal ependymomas that were surgically treated with gross total resection in our clinic from 1995-2009. No adjuvant treatments (including radiotherapy) were used in the postoperative period. We observed and evaluated our patients' surgical and clinical results over a follow-up period that averaged 4.6 years.

As a result of clinical observations and periodic follow-up examinations, we determined two important factors that affect prognosis and clinical results. First, the patient needs to have a good neurological condition before the operation[6]. This depends on early diagnosis and early surgical treatment of the pathology before it causes permanent neural damage. We observed that patients who entered the operation with normal neurological function also had normal neurological function or mild/moderate neurological deficits in the early postoperative period (Table 2).

The second prognostic factor is the use of a gross total resection of intramedullary and extramedullary ependymomas during the microsurgical operation[1,2,4,9,11,12,14,15]. We performed gross total resections on all of our cases, as confirmed by postoperative MRI examinations. Even though four patients developed mild/moderate neurological deficits in the early period after tumour resection, at the 6-month neurological examination three of them were evaluated as normal. The remaining patient's neurological function was improved to normal by the 14th month. Only one patient (5%), who was preoperatively McCormick grade 4, was treated with gross total resection and did not make a complete recovery. At the 15-month examination, that patient's neurological functions were evaluated as McCormick grade 2.

Surgical treatment of spinal cord tumours is now standardised. Earlier reports showed the total tumour resection rate in spinal ependymomas to be approximately 70%[5]. Recently, factors such as improvements in imaging techniques (Gadolinium-Enhanced MRI), the widespread use of microsurgical techniques and increased surgical experience, the widespread usage of CUSA in intramedullary ependymoma resection, and the usage of intraoperative neurophysiological monitoring have caused an increase in total resection rate to 90%[1,7,14,17,23].

In their intramedullary spinal ependymoma series of 82 cases, Aghakkani et al.[1] performed total tumour resections on 75 (91.5%) cases. Nakamura et al.[14] reported an intramedullary spinal tumour series of 68 cases of which 33 cases were diagnosed as intramedullary ependymomas. They performed total tumour resections in 30 (91%) cases. Nevertheless, some recent publications reported lower rates of total resection. Raco et al.[15] reported 68 ependymoma cases in their series of 202 cases; they performed total resection on 55 (81%) cases and subtotal resection on 13 (19%) cases. Lin et al.[9] reported a spinal ependymoma series of 20 patients; they performed total resection on 13 (65%) cases and subtotal resection on 7 (35%) cases. Similarly, in their intramedullary tumour series of 66 cases, Manzano et al.[10] reported achieving a gross-total resection rate of 69.2%. In our opinion, differences between gross total resection rates in these series could be due to variations in surgical experience and in the techniques that were used. We attribute our success with gross total resection to our experience in the surgery of these tumours, the use of state-of-the art operational equipment and the use of CUSA in absolutely all cases. By utilizing intraoperative pathology examinations on frozen tumour samples, we aim to achieve total resection, especially when the intraoperative pathological diagnosis is ependymoma.

According to many authors, the aim of intramedullary ependymoma surgery is gross total resection and protection of neurological function[1,2,4,9,11,12,14,15]. It has been reported that gross total resection is usually sufficient to achieve recovery of the lesions or the long-term control of the tumour[2,9,12,17]. McCormick et al.[12] recommended a total resection of spinal cord ependymomas whenever possible, and in a 12-year-long follow-up study they reported low morbidity and excellent long term control in a series of 23 patients. As a result of a long-term follow-up study of 202 cases, Raco et al.[15] reported that the surgical goal should be the removal of the entire spinal cord ependymoma.

None of our cases received postoperative radiotherapy. The dominant opinion in the literature is that the standard treatment for ependymomas is radical resection, and that radiation therapy after gross total resection is unnecessary[3,4,12,16]. However, when there is a possibility of residual tumours or a diagnosis of malignant ependymoma, postoperative radiotherapy is recommended[19].

We performed gross total resections and did not use neurophysiological monitoring with somatosensory evoked potentials during surgery in our spinal ependymoma series. After three years of experience, Raco et al.[15] observed that intraoperative neurophysiological monitoring is not helpful for determining postoperative motor and sensory deficits. However, Kelleher et al.[8], in their prospective study of 1,055 cases, reported that electromyography, somatosensory evoked potential recordings and selective use of meningioma en plaque are helpful for preventing neurological injuries in cervical region surgery. We do not have any experience with intraoperative neurophysiological monitoring.

Even after gross total resection, benign intramedullary tumours may carry a recurrence risk[2]. Long-term clinical and radiological follow-up should be carried out in such cases[17]. Each year, a routine gadolinium-enhanced MRI examination is recommended because radiological evidence of tumour recurrence usually appears before clinical findings[2,7]. We encountered tumour recurrence in only one (5%) patient during the average 4.6 years of radiological and clinical follow-up in our cases.

CONCLUSION

The determining factors for optimal clinical results after spinal ependymoma surgery are a gross total resection of the tumour and good neurological condition before the operation. In order to achieve good functional results, it is very important to diagnose spinal ependymomas early and to perform an early surgical operation before permanent neural injury occurs in the spinal cord. In spinal ependymomas, if the tumour is totally resected and this is radiologically confirmed, postoperative radiotherapy is unnecessary.

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