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METASTATIC TUMORS OF THE SPINAL CORD; SECONDARY INTRAMEDULLARY TUMORS

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ABSTRACT

Objective: Intramedullary tumor metastasis in the spinal cord is a rare clinical entity but is increasing in incidence due to advances in primary tumor treatment and longer survival. The authors present one of the most extensive patient series yet on intramedullary spinal cord metastasis to provide treatment guidance for improved quality of life.

Materials and Methods: All spinal tumor cases treated between January 2012 and May 2021 at the Neurosurgery Department, Bahçeşehir University Faculty of Medicine, were screened for intramedullary spinal cord metastasis.

Results: Fifty-one patients were treated for spinal intramedullary lesions during the study period, of which 11 were diagnosed with radiologically and (or) pathologically confirmed intramedullary spinal cord metastasis (median age at presentation: 50 years, 54.5% female). Ten of these 11 patients received surgical intervention, and five (45.5%) were previously treated for primary breast cancer. The metastatic spinal lesion was cervical in 5 patients (45.5%), thoracic in two (18.2%), and within the conus medullaris in three (27.3%). The patient not receiving surgical intervention presented with a lesion at C2. Eight of 11 patients (72.7%) had accompanying intracranial metastasis, and 7 (63.6%) required additional neurosurgical interventions. Seven patients (63.6%) also presented with systemic metastasis requiring radiotherapy, systemic chemotherapy, or both, among whom four patients (36.4%) received post-operative radiotherapy. The median overall survival was only six months, but the median Modified McCormick scale score for neurological status improved (decreased) significantly post-surgery (2.5 vs. 4 pre-surgery, $p<0.001$).

Conclusion: Despite effective local and systemic treatment modalities, overall survival is short among patients with intramedullary spinal cord metastasis. Therefore, the main aims of surgery are to prevent further neurological decline and improve health-related quality of life.

Keywords: Spinal cord, metastasis, surgical excision

INTRODUCTION

Intramedullary metastasis of the spinal cord accounts for only 0.6% of all spinal cord tumors, and thus is rarely encountered in neurosurgical practice[1]. However, it is estimated to account for 4.2%-8.5% of metastases diagnosed in the central nervous system (CNS), and is expected to increase in frequency with continued advances in primary tumor treatment[2]. Metastatic spinal tumor has deleterious effects on health-related quality of life and so warrants careful review of past cases to provide guidance for best possible treatment. This study reviews radiologically and (or) pathologically confirmed intramedullary spinal cord metastasis cases treated at a single neurosurgery department over a 9-year period.

MATERIALS AND METHODS

All patients treated at the Neurosurgery Department, Bahçeşehir University School of Medicine, between January 2012 and August 2021 were screened for intramedullary spinal cord metastasis. Inclusion criteria were: (I) radiological and/or histopathological confirmation of an intramedullary metastatic lesion within the spinal cord parenchyma, (II) management at our center during the study period, and (III) availability of baseline clinical examination and MRI, with a 4-week post-operative assessment for surgical cases [Modified McCormick scale (MMCS)]. No age restrictions were applied (adult and pediatric patients were eligible). Exclusion criteria were: (I) intradural extramedullary or leptomeningeal-only metastases without

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parenchymal intramedullary involvement, (II) primary intramedullary neoplasms, and (III) insufficient clinical or imaging documentation for analysis. During this period, 173 patients were treated surgically for spinal tumors, including 51 patients with spinal intramedullary neoplasms. Of this latter group, 11 had radiologically or pathologically confirmed intramedullary spinal cord metastasis (Table 1), 10 of which received surgical intervention based on radiological appearance and systemic condition. Written informed consent was obtained from all patients (or their legally authorized representatives) prior to surgery, and all surgical procedures were performed under neurophysiological monitoring. Neurological status was evaluated using the MMCS[3] (Table 2) at presentation and four weeks after surgery. Overall survival was defined as the time between surgery and all-cause death. The study was approved by the Local Ethics Committee of Bahçeşehir University School of Medicine (approval number: 2025-10/03, date: 01.07.2025).

Statistical Analysis

All clinicodemographic data were analyzed using the Statistical Package for the Social Sciences for Windows 23.0 (IBM). Categorical variables are presented as frequency and percentage, while continuous variables are presented as median (minimum and maximum). Median post-operative survival was calculated by Kaplan-Meier curve analysis, and the effect of primary tumor surgery on survival was assessed by the log-rank test. Post-operative MMCS scores were compared to pre-operative scores using the Wilcoxon signed rank test. A p-value less than 0.05 was considered statistically significant for all tests.

RESULTS

Ten of 11 patients with confirmed intramedullary spinal cord metastasis received surgical treatment, of which two were in the pediatric age group (overall median age at presentation: 50 years, range: 7-65; 54.5% female). The most common primary malignancy was breast cancer (5 of 11 patients, 45.5%), followed by lung cancer (2 patients, 18.2%), while mixed germ cell tumor, undifferentiated carcinoma, and granulocytic-myeloid sarcoma plus acute myeloid leukemia were the primary malignancies in one patient each (9.1%). The confirmed intramedullary spinal cord metastasis patient not treated surgically was a 35-year-old female with a previously operated gliosarcoma in the occipital region. She was admitted to the emergency room with sudden-onset loss of consciousness. Cranial magnetic resonance imaging with intravenous gadolinium enhancement revealed multiple supratentorial lesions with an accompanying intramedullary lesion at the C2 level. Due to poor neurological and systemic conditions, anti-oedematous treatment was performed, and the patient died on the seventh day of hospital admission.

The locations of the other metastasis lesions were as follows: cervical (5 patients, 45.5%), thoracic (2 patients, 18.2%), and conus medullaris (3 patients, 27.3%). One patient received surgical intervention twice for two different lesions six months apart, the first in the cervical region and the second in the thoracic region (Tables 3 and 4). Eight patients (72.7%) experienced recurrent intracranial metastasis during follow-up. Of these, seven patients (63.6%) required additional neurosurgical interventions, including gamma knife radiosurgery, craniotomy for intracranial metastasis, and ventriculoperitoneal (VP) shunt placement (Tables 3 and 4). The one patient with multiple intracranial lesions deemed ineligible for surgery received whole-brain radiotherapy.

Seven patients (63.6%) developed systemic metastasis requiring additional treatment (radiotherapy, systemic chemotherapy, or both). One patient was not further evaluated for systemic metastasis due to sudden neurological decline and death. Four patients (36.4%) also received post-operative radiotherapy to the surgical site. The median time from initial primary tumor diagnosis to intramedullary metastasis diagnosis was 12 months in our series (range: 0-129 months). The 12-month survival rate post-operatively was 18%, and the median overall survival rate was six months (range: 0.25-83) (Figure 1). There was no difference in median survival between patients with and without previous primary tumor surgery (Figure 2). The median MMCS score differed significantly following surgery

Table 1. Summary of the patient data

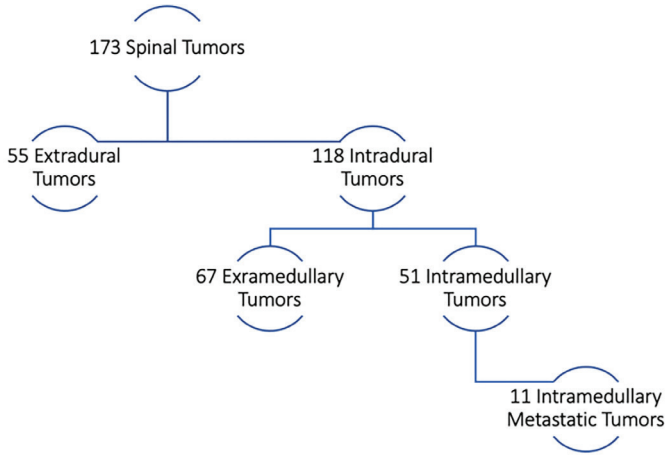

Table 2. Modified McCormick scale

Grade	Definition
I	Neurologically intact, normal ambulation, minimal dysesthesia
II	Mild motor or sensory deficit, functional independence
III	Moderate deficit, limitation of function, independent with external aid
IV	Severe motor or sensory deficit, limited function, dependent
V	Paraplegia or quadriplegia, even with flickering movement

Table 3. Pre- and post-operative summary of the patient data

Patient number	Age	Sex	Primary malignancy	Location	Pre-operative MMCS	Post-operative MMCS	Post-operative survival
1	46	Female	Breast	C4-5	II	I	83 months
2	33	Female	Breast	T11-12	IV	II	4 months
3	54	Female	Breast	Conus medullaris	II	I	18 months (under follow-up)
4	56	Female	Breast	Conus medullaris	III	II	2 months
5	65	Male	Lung	Conus medullaris	V	IV	6 months
6	50	Male	Lung	C7 T4-6	II III	I II	12 months 6 months
7	35	Female	Gliosarcoma	C2	N/A	N/A	1 week
8	7	Male	Mixed germ cell tumor (>95% yolk sac)	C3-5	IV	III	5 months
9	64	Male	Undifferentiated carcinoma	C5-7	V	IV	1 month
10	64	Female	Breast	C5-7	V	IV	6 months
11	10	Male	Granulocytic-myeloid sarcoma	T8-10	IV	III	7 months

MMCS: Modified McCormick scale, N/A: Not applicable

Table 4. Characteristics of the patient data

Characteristics	n (%) or median (min-max)
Sex	
Female	6 (54.5)
Male	5 (45.5)
Age, years	50 (7-65)
Primary malignancy	
Breast	5 (45.5)
Lung	2 (18.2)
Other	4 (36.4)
Primary tumor surgery	
No	4 (36.4)
Yes	7 (63.6)
Location	
Cervical	5 (45.5)
Cervical and thoracic	1 (9.1)
Conus	3 (27.3)
Thoracic	2 (18.2)
Pre-operative MMCS	4 (2-5)
Post-operative MMCS	2.5 (1-4)
Post-operative survival in months	6.0 (0.25-83.0)
Intracranial metastasis	
No	3 (27.3)
Yes	8 (72.7)
Systemic metastasis	
No	3 (27.3)
Yes	7 (63.6)
N/A	1 (9.1)

Table 4. Continued

Characteristics	n (%) or median (min-max)
Post-operative RT	
No	6 (54.5)
Yes	4 (36.4)
N/A	1 (9.1)
Post-operative KT	
No	3 (27.3)
Yes	7 (63.6)
N/A	1 (9.1)
Diagnosis-metastasis time period, months	12 (0-129)
RT history	
No	1 (9.1)
Yes	10 (90.9)
Additional neurosurgical intervention requirement	
No	4 (36.4)
Yes	7 (63.6)
Subtypes of additional neurosurgical intervention	
Gamma knife	1 (9.1)
Craniotomy	2 (18.2)
Craniotomy and gamma knife	2 (18.2)
VP shunt	1 (9.1)
VP shunt and gamma knife	1 (9.1)
Overall survival	
Alive	1 (9.1)
Exitus	10 (90.9)

MMCS: Modified McCormick scale, N/A: Not applicable, RT: Radiotherapy, KT: Chemotherapy, VP: Ventriculoperitoneal

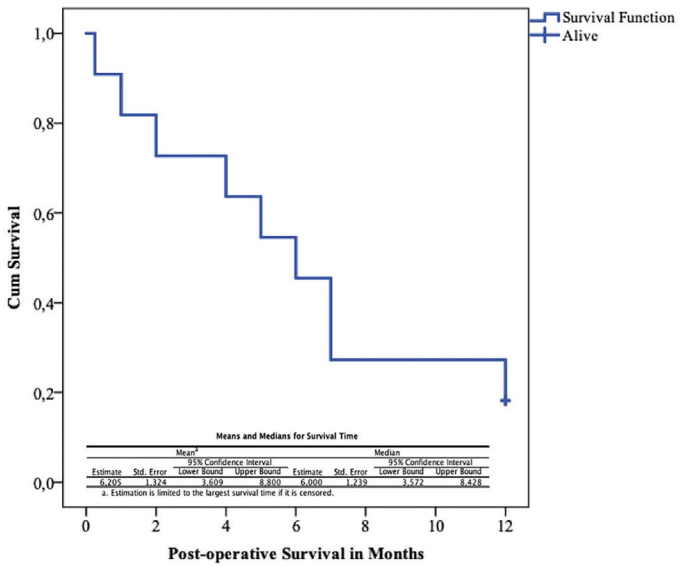

Figure 1. Twelve-month survival of all patients identified with confirmed intramedullary spinal cord metastasis

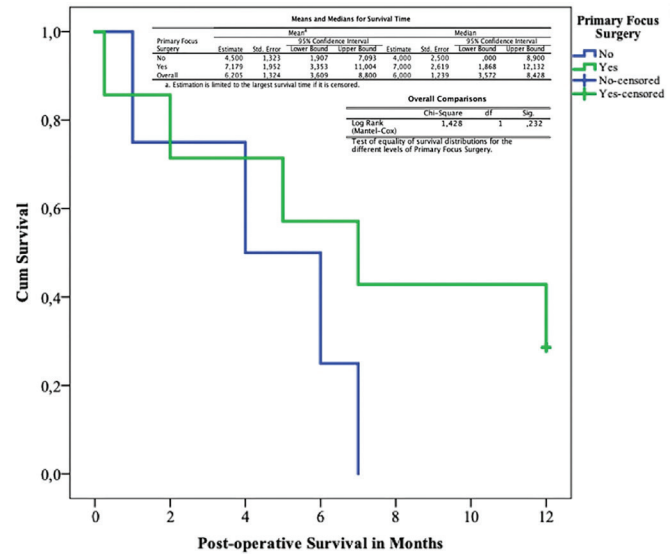

Figure 2. Twelve-month survival rates of patients with and without previous primary tumor surgery

compared to the pre-operative period (2.5 vs. 4.0, p<0.001) (Table 5). Illustrative pre- and post-operative neuroimages of intramedullary spinal cord metastasis in cervical and conus medullaris regions are presented in Figures 3 and 4, and histological images of an intramedullary spinal cord metastatic tumor are presented in Figure 5.

DISCUSSION

CNS metastatic tumors are usually intracranial, while intramedullary spinal cord metastases represent only 0.1%-8.5% of all CNS metastasis cases[4-6]. Metastases in the CNS originate most frequently from primary lung tumors, followed by breast

Table 5. Comparison of the pre-operative and post-operative MMCS

	Median	Minimum	Maximum	p-value
Pre-operative MMCS	4.00	2.00	5.00	<0.001
Post-operative MMCS	2.50	1.00	4.00	

MMCS: Modified McCormick scale

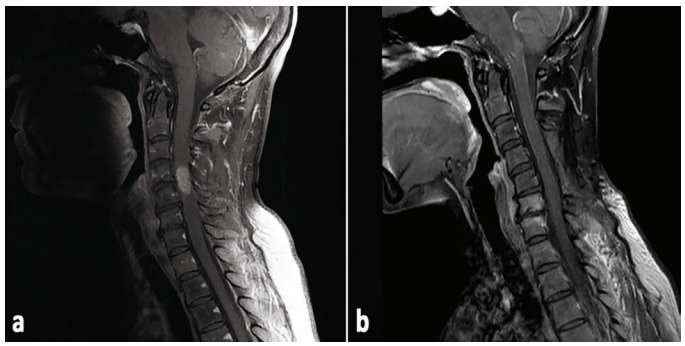

Figure 3. Neuroimaging examination of a patient with confirmed intramedullary spinal cord metastasis in the cervical region. The patient was a 46-year-old female with primary breast cancer. (a, b) Pre-operative (a) and post-operative (b), sagittal T1-weighted cervical MR images following IV gadolinium injection. MR: Magnetic resonance, IV: Intravenous

cancers and lymphoma[6]. Patients with intramedullary spinal cord metastasis usually present with neurological deficits, most commonly sensory deficits and sphincter dysfunction. However, intramedullary spinal cord metastasis is the initial presentation in up to 22.5% of patients[5,7].

The characteristics of the current series are similar to those reported previously, although breast tumors were a more frequent origin. The most common site for intramedullary metastasis was the cervical region (Figures 3 and 5), consistent with previous reports[7,8], followed by conus medullaris and the thoracic segments (Figure 4). The median period from diagnosis of the primary tumor to detection of intramedullary metastasis in our series was 12 months, again consistent with previous studies[2], although the range was broad (0-129 months). Unfortunately, median overall survival time in the current series was only six months (range: 0.25-83), and only 18% of the patient population was alive by the twelfth post-operative month (Table 3). Nonetheless, survival times were actually longer than in previous reports[2,9,10]. Of the two patients surviving more than 12 months, one was alive after 83 months, and the other after 18 months. Survival time was not influenced by primary tumor treatment (Table 4), although much larger multicenter series are required to assess the influences of primary tumor characteristics and treatment modalities on survival. For instance, almost all patients in the current cohort had operable primary lesions, so comparisons with inoperable primary lesions were not possible. The relatively short survival durations in this and previous studies may be

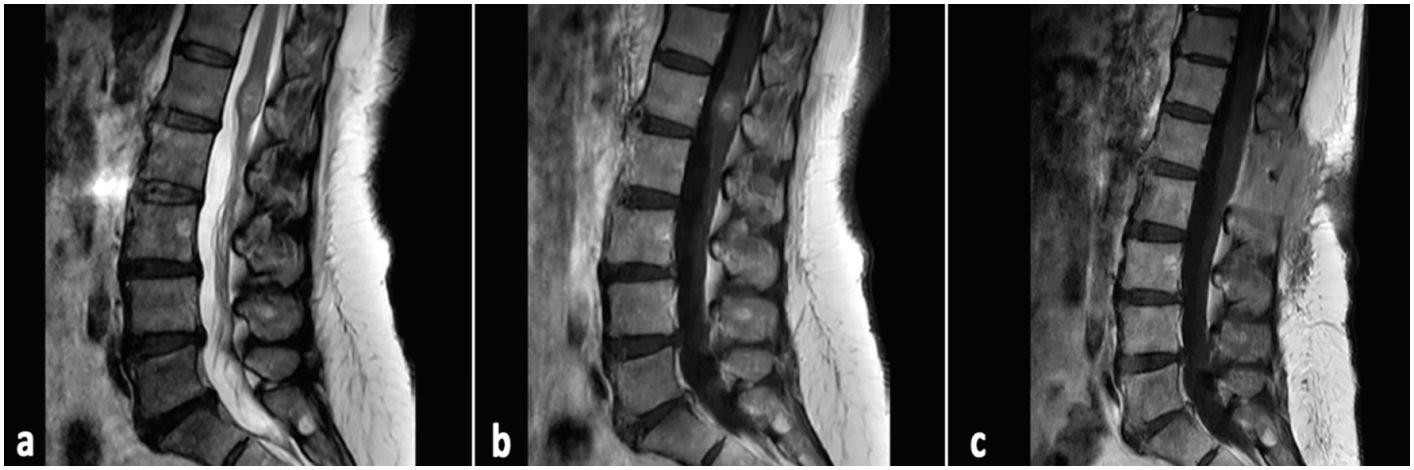

Figure 4. Neuroimaging examination of a patient with confirmed intramedullary spinal cord metastasis in the conus medullaris region. The patient was a 54-year-old female with primary breast cancer. (a, b) Pre-operative sagittal T2-weighted, (a) and sagittal T1-weighted, (b) lumbar MR image following IV gadolinium injection, (c) post-operative sagittal T1-weighted lumbar image following IV gadolinium injection. MR: Magnetic resonance, IV: Intravenous

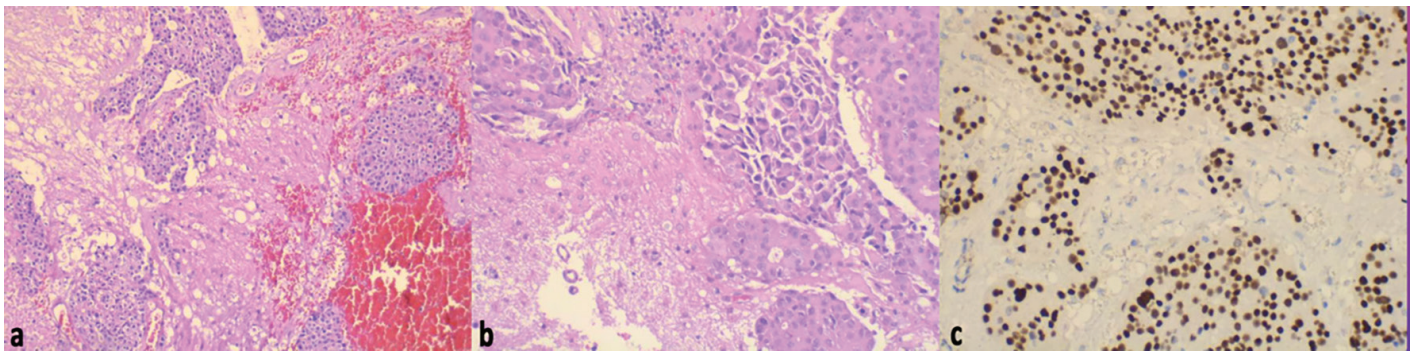

Figure 5. Histological analysis of confirmed intramedullary spinal cord metastasis in the cervical region. (a, b) Hematoxylin and eosin staining showing infiltration of metastatic islands into neuroglial tissue (a: ×100 magnification; b: ×200 magnification). (c) Immunostaining with the nuclear tumor cell marker GATA, consistent with breast cancer metastasis (×200 magnification)

explained by broader metastasis. Eight (72.7%) patients in this study either had accompanying intracranial metastasis at the time of intramedullary metastasis diagnosis or during follow-up, and seven required additional neurosurgical intervention (gamma knife radiosurgery, craniotomy, or VP shunt placement). There was, however, a significant decline in the MMCS score in the post-operative period ($p<0.001$), indicating improved neurological status. This finding supports the efficacy of surgical intervention for improving patient quality of life.

CONCLUSION

Despite advances in local and systemic treatments, the overall survival of patients with intramedullary spinal metastasis is relatively short, although there are rare cases of several for several years (Figure 3). Therefore, the main aim of surgery is to prevent further morbidity caused by the metastatic component of the primary tumor and to improve quality of life.

Ethics

Ethics Committee Approval: The study was approved by the Local Ethics Committee of Bahçeşehir University School of Medicine (approval number: 2025-10/03, date: 01.07.2025).

Informed Consent: Written informed consent was obtained from all patients (or their legally authorized representatives) prior to surgery, and all surgical procedures were performed under neurophysiological monitoring.

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Footnotes

Authorship Contributions

Surgical and Medical Practices: Z.O.T., D.K., Concept: G.D.O., Z.O.T., D.K., Design: G.D.O., Z.O.T., D.K., Data Collection or Processing: G.D.O., B.P., Analysis or Interpretation: G.D.O., B.P., Literature Search: G.D.O., B.P., Writing: G.D.O., B.P., Z.O.T., D.K.

Conflict of Interest: No conflict of interest was declared by the authors.
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