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NEOPLASTIC CAUSES OF SPINAL CORD AND CAUDA EQUINA COMPRESSION IN ADULTS: PATHOLOGICAL AND STATISTICAL FEATURES*

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ABSTRACT

This presentation analyses the histological types, relative incidences, age, sex and anatomical distributions of one hundred and seventy-nine biopsy proven tumors of the spinal canal from a general hospital in Iran. Particular attention is paid to differences in the relative incidence of these tumors compared with that in various published reports and the statistics from several eastern countries are compared with those from the West.

In the patients studied, secondary tumors were the most frequent causes of spinal cord and cauda equina compression (39.6%), followed by nerve sheath cell tumors (24.5%), meningiomas (20%) and neuroepithelial tumors (10%). Among the secondary tumors, the most common metastatic tumor was the lymphoma and the most common vertebral column neoplasm was the myeloma, each accounting for 8.9% of the entire series, an unusually high proportion for the myeloma.

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INTRODUCTION

Patients with neoplastic spinal cord or cauda equina compression are treated by neurosurgeons, orthopedic surgeons, radiotherapists and a small proportion by other specialists. Therefore relatively unbiased statistical data on spinal canal tumors can be obtained from the population of patients with such conditions presenting to a general hospital rather than from cases treated in a specialty referral center. However, in the group not undergoing surgery, the precise definition of pathological features of neoplasms is difficult, if not impossible. The author reviewed the Nemazee Hospital surgical experience with spinal canal tumors during a 25-year period in an attempt to 1) analyze surgically treated neoplastic causes of spinal cord and cauda equina compression in adult patients attending this general hospital, and 2) obtain data on spinal canal neoplasms in this part of the world. It is desirable to have such data for various nations and ethnic groups, as comparison of this information might provide relevant clues to etiologic factors.

MATERIAL AND METHODS

In reviewing 70,908 reports of surgical specimens dated from January, 1962 through December, 1986 in the Department of Pathology of the Nemazee Hospital in Shiraz and examining the clinical records of the material so-obtained, one hundred and seventy-nine patients were identified for this study. All the patients were 15 years of age or older when undergoing surgery and had neurological dysfunction due to neoplasms arising within or encroaching upon the neural contents

* This is the summary of a monograph by the author on the pathological and statistical features of spinal canal tumors.

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TABLE I.
Histological classification, number of cases and relative incidences of 179 adult spinal canal tumors.

Tumor Type*	No. of cases	Relative Incidence (%)
tumors of neuroepithelial tissue	18	10
astrocytoma (5)		
giloblastoma (1)		
ependymoma (10)		
oligodendroglioma (1)		
ganglioglioma (1)		
nerve sheath cell tumors	44	24.5
meningioma	36	20.1
vascular tumors and malformations	4	2.2
hemangioblastoma (2)		
hemangioma** (1)		
arteriovenous malformation (1)		
congenital tumors	2	1.1
dermoid (1)		
lipoma (1)		
secondary tumors	71	39.6
metastatic tumors (41)		
vertebral column tumors (30)		
unknown	4	2.2
total	179	

* Values in parentheses indicate the number of patients.
** Purely extraduralcavernousangioma with no evidence of bone involvement.

of the spinal canal. Vertebral column tumors were considered in this study if the patient presented to the hospital with the manifestations of spinal cord or cauda equina involvement; cases with local or radicular pain were not included. All the diagnoses were made with light microscopy. When questions arose about the histopathological diagnosis, the slides were reviewed with a senior neuropathologist. The slides of 84 cases were reexamined. Data regarding the age and sex of the patients and the anatomical distribution of tumors were obtained from the clinical records and operative notes. This survey uses the World Health Organization classification for central nervous system and bone tumors.[36-40] The slides of patients with the non-Hodgkin's lymphoma were reexamined and classified according to the criteria of Rappaport, et al.[28]

RESULTS

One hundred and forty three patients had spinal cord compression (80%), and the other 36 had cauda equina involvement (20%). The neoplasm was primary in 104 cases (58%) and secondary in 71(40%); in the remaining four (2%) a definite histopathological diagnosis could not be made (Table I). Nerve sheath cell tumors (NSCT's) were the most common primary tumors, followed by meningiomas, tumors of neuroepithelial tissue, vascular tumors and malformations, and congenital tumors in descending order of frequency. The average age of the patients at the time of surgery was 37.3 years, with a range of 15 to 70 years. 93 were male and 86 female. There were fifteen patients 60 years of age or older (8.3%); and the most common tumor in this age group was the meningioma (Table II). The thoracic canal was the most frequent site of occurrence, followed by the lumbar and cervical regions (Table III). The lower thoracic segments were more commonly involved than the upper ones (56 versus 41). The tumor was extradural in 88 patients (49%), intradural in 64 (36%), dumbbell type in eight cases (4%), sixteen patients had intramedullary tumors (9%), and in 3 instances the location of the neoplasm was not recorded. Of the 64 intradural tumors, 47 were intradural, extramedullary (73.5%); the other 17 were in the region of the cauda equina (26.5%), and of the eight dumbbell tumors, only one was in the region of the cauda equina (12.5%) and the other seven were juxtamedullary (87.5%). Secondary tumors far outnumbered primary neoplasms in the extradural space (Table IV). Meningiomas were more frequent than NSCTs in the intradural extramedullary space (Table V) and NSCTs were the most common neoplasms of the cauda equina (Table VI). Astrocytomas and ependymomas were the two leading intramedullary tumors (Table VII).

TABLE II.
Spinal canal tumors in patients 60 years of age or older.

Tumor Type	No. of cases
meningiomas	5
metastatic carcinomas	3
myelomas	3
nerve sheath cell tumors	3
astrocytoma	1
total	15

In the group of neuroepithelial tumors, there were six astrocytic neoplasms, 10 ependymomas and one case each of oligodendroglioma and ganglioglioma. The mean age in six patients with astrocytic tumors was 34.3 years. Five had grade I or II astrocytomas, the other had a glioblastoma. Four of the five patients with low grade astrocytomas were men. Of the 10 ependymomas, five were in the region of the cauda equina and five within the spinal cord proper. The average age of patients with ependymomas was 33.4 years; seven were women and three were men.

Forty four patients had NSCTs. Their ages ranged from 15 to 65 years with an average of 36 years. Males outnumbered females (26/18). The mean age for males was 38.6 years and for females 32.6 years. The tumor occurred with an equal incidence in the cervical and thoracic regions (Table III), and the lumbar canal was

TABLE III. Distribution of tumors along the spinal canal.*

Location of Tumor	Total Cases		NSCT‡		Meningioma		Metastatic Carcinoma		Lymphoma		Myeloma	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
cervical	32	18	15	34	6	16.6	-	-	1	6.25	1	6.25
cervicothoracic	4	2	2	4.5	-	-	1	5	1	6.25	-	-
thoracic	97	54	15	34	29	80.5	10	50	8	50	10	62.5
thoracolumbar	2	1	-	-	-	-	1	5	1	6.25	-	-
lumbar	41	23	12	27.5	1	2.7	7	35	4	25	4	25
lumbosacral	1	0.5	-	-	-	-	1	5	1	6.25	-	-
sacral	3	1.5	-	-	-	-	-	-	-	-	1	6.25
total	180		44		36		20		16		16	

* A patient with carcinoma of the prostate had spinal cord compression at two levels at the time of presentation.
NSCT = nerve sheath cell tumor.

next in frequency. In the thoracic area, the higher incidence was in its lower half, with 11 of 15 thoracic NSCTs, in the lower half of the thoracic canal. The frequencies of intradural, extradural and dumbbell NSCTs in the different parts of the spinal canal appear in Table VIII. In 10 of 15 patients with NSCTs in the extradural space, including those with dumbbell tumors, it was reported that the neoplasm had extended into the intervertebral foraminae or paravertebral region.

Seven patients had evidence of Von Recklinghausen's neurofibromatosis. Three of them had multiple neurofibromas with the myelographic block in the cervical region. Another two had apparently solitary neurofibromas, also in the cervical region. All five had cafe au lait spots, multiple subcutaneous nodules or both. Another patient had multiple meningiomas in the upper thoracic canal with multiple cafe au lait spots. The mean age in these six patients was 19 years. A 30-year-old man had a dumbbell schwannoma at the T12 level and a parasagittal parietal meningioma five years later.

There were 36 cases of meningioma, ranging in age from 16 to 65 years with an average of 41.5 years. Thirty-one were women (86%) and five were men (14%). The mean age for women was 43.6 years and for men 28.6 years. The neoplasms were predominantly in the thoracic region (80%), and only one patient had a lumbar meningioma (Tables III and IX). The anterior or posterior location of the tumor with reference to the spinal cord was recorded in the operative note in all six patients with cervical tumors and 21 cases with thoracic meningiomas.

The neoplasm was anterior to the cervical cord in four of the six (67%), while it was anterior to the thoracic cord in four of the 21 (19%). The difference is statistically significant (chi-square: P= 0.02). The tumor was intradural in 29 patients (80.5%) and extradural in six (16.5%); in the remaining one the location of the neoplasm was not specified (Table IX). In only one of the six extradural meningiomas, the surgeon had ruled out the intradural component of the tumor. The mean age of the patients with extradural meningiomas was 37.1 years, approximately five years less than that of the patients with intradural tumors (41.7 years). The extradural meningiomas affected both sexes equally, whereas the patients with intradural neoplasms were mainly female (93%) (Table IX). In the women, the incidence of thoracic meningiomas greatly surpassed that of cervical lesions, but in the men, neoplasms had an almost even distribution in the various parts of the spinal canal. Three of the six extradural meningiomas were invasive, three of them had profuse bleeding at the time of laminectomy, and

TABLE IV. Extradural tumors

Tumor Type	No. of Cases
metastatic tumors	41
vertebral column tumors	30
nerve sheath cell tumors (including 8 dumbbell)	15
meningiomas	6
hemangioma*	1
unkown	3

*Purely extradural cavernous angioma with no evidence of bone involvement.

TABLE V. Intradural extramedullary tumors

Tumor Type	No. of Cases
meningiomas	28
nerve sheath cell tumors (including 7 dumbbell)	24
hemangioblastomas	2

TABLE VI. Cauda equina tumors.

Tumor Type	No. of Cases
nerve sheath cell tumors (including one dumbbell)	12
ependymomas	5
meningioma	1

TABLE VII. Intramedullary tumors.

Tumor Type	No. of Cases
astrocytomas	5
glioblastoma	1
ependymomas	5
oligodendroglioma	1
ganglioglioma	1
lipoma	1
dermoid	1
unknown	1

one of the latter had the microscopic features of an angiomatous meningioma. However only one of the intradural meningiomas was invasive; this was the only lumbar angiomatous meningioma.

There were forty-one metastatic tumors, all epidural in location (Tables I and X). Nineteen patients had metastatic carcinomas, 14 men and five women (2.8/1), ranging in age from 20 to 70 years with a mean of 46 years. In 17 of the 19, spinal cord dysfunction was the first manifestation of an occult neoplasia, while the other two were known to harbor malignancy once paraplegia developed. The primary malignancy was found in the perioperative work-up in eight of the 17, and six months after operation in one case with a bronchogenic carcinoma.

The distribution of the metastatic carcinomas within the length of the spinal canal is shown in Table III. In 15 of the 19 patients with these tumors, data regarding bone involvement could be obtained from their clinical records. Four patients had pure epidural tumors (27%) and in 11 cases the vertebrae were also involved (73%). None had evidence of compression fracture.

There were sixteen epidural lymphomas: 12 non-Hodgkin's lymphomas (NHL's) and four Hodgkin's lymphomas. The age of patients with lymphomas ranged from 15 to 56 years (average 31.5 years). The mean age in patients with NHL was 29 years with seven men and five women whereas the mean age in cases of Hodgkin's disease, all men, was 40 years. All the patients with NHL had diffuse lymphomas and diffuse poorly differentiated lymphocytic lymphoma was the most frequent subtype (Table XI). In two of the 12 patients with NHL, the neoplasia had been previously diagnosed, eight months before laminectomy with deposition of the tumor in the frontal bone in one, and seven months before laminectomy by laparotomy for an abdominal mass in the other. In the other ten, spinal cord dysfunction represented the initial manifestation of the NHL. Of these 10, two were found to have evidence of the lymphoma outside the spinal canal in the perioperative work-up. By comparison, three of the four patients with Hodgkin's lymphomas were known cases of Hodgkin's disease for a mean of five years and the remaining one was found to have extraspinal involvement in the postoperative work-up. The distribution of the lymphomas within the length of the spinal canal is shown in Table III. In four of the 16 patients with lymphomas, the tumor invaded the vertebral column (25%) and the other 12 had no evidence of bone involvement (75%).

Spinal cord or cauda equina compression was due to tumors of vertebral column origin in 30 cases (Tables I and XII). In a 20-year-old man, paraparesis and myelographic block were due to a bony projection into the spinal canal at the C7 level. Biopsy from this hard mass revealed normal bone; this had probably been an osteochondroma or less likely an osteoma (Table XII).

Sixteen patients had myelomas. Their mean age was 45.4 years with a range of 24 to 60 years. Eleven were men and five were women. The thoracic region was most frequently involved (10 cases, Table III). In eight of the 10 the tumor was in the lower half of the thoracic spine. In all of the patients with myelomas, neurological dysfunction was the first manifestation of the disease but only one of them had the diagnosis of myeloma before operation. The other 15 were diagnosed via the tissue removed at surgery. Thirteen of the 16 patients had radiological evidence of compression fracture or vetebral collapse.

TABLE VIII. Anatomical distribution of nerve sheath cell tumors.*

Tumor Location	Level of Tumor				Total Cases	
	Cervical	Cervicothoracic	Thoracic	Lumbar	No.	%
intradural	7	1	9	11	28	65
extradural	4	-	3	-	7	16
dumbbell	4	1	2	1	8	19

* In one patient, the location of the tumor in relation to the dura was not recorded.

TABLE IX. Anatomical and sex distributions of meningiomas.*

Sex	Tumor Location			Level of Tumor	
	Intradural	Extradural	Cervical	Thoracic	Lumbar
female	27	3	4	27	-
male	2	3	2	2	1
total	29	6	6	29	1

* In one patient, the location of the tumor in relation to the dura was not recorded.

DISCUSSION

The relative frequencies obtained in this study are not representative of the true figures for the community, because the present material has been identified through the reports of surgical specimens, a situation that favors operable cases. Depending on the source of the material studied in a population, the constitution of the statistics obtained varies. Necropsy series usually demonstrate more benign and indolent neoplasms[27] while materials from oncological centers tend to represent a large proportion of metastatic tumors. In contrast, surgical series of spinal canal neoplasms generally contain a lower percentage of metastatic tumors. Even among different surgical series, the proportion of metastatic tumors vary depending on the policy in a center to treat patients with known cancer surgically or by non-surgical modalities when developing paraplegia. Therefore the comparison of data from different sources in various communities can not reveal real differences among the communities. Moreover, the diversity in the types of tumors included and the classification used in different series further complicates the collation of statistics. For the analysis of the data obtained in this study, the most comparable series in the literature are reviewed. However, they still have some dissimilarities in the material and method of the study. Despite these dissimilarities, comparison of these series may reveal important points on the relative frequency of spinal canal tumors in different parts of the world. Most series reviewed in this article contained a proportion of autopsy-proven cases though this was not usually a considerable number in each series. Moreover they often comprised all age groups. The present material is a pure surgical series and did not include patients under 15 years of age that make up roughly 10% of patients with spinal canal neoplasms in all age groups.[1,32] Table XIII compares the relative incidences of spinal canal tumors obtained in this study with those in several eastern and an extensive western series (the latter has been collected from the literature).

Comparison of the data on the age of patients from this study with those reported from the Mayo Clinic indicates that the patients in the current series were on average nearly 10 years younger. For example, the mean ages of the Patients with NSCTs and meningiomas were 36 and 41.5 years, respectively, in this study and 44 and 50 years in the Mayo Clinic report.[33] The difference was more striking in epidural lymphomas, the median age of patients with this lesion being 20 years in the present series and 48 years in the Mayo Clinic report.[14] Such discrepancies exist despite excluding patients under 15 years of age in this study. Certainly the average age of the entire series would be lower than 37 years if patients younger than 15 years old were also included. Similar findings have been reported from China in a study of about 25,000 tumors of the central nervous system (CNS), in which the mean age was 35 years, nearly 10 years less than that in comparable reports.[33]

Neuroepithelial tumors constituted 10% of the spinal canal tumors in this series (Table I), a proportion lower than that reported from the West (Table XIII). Most of the eastern reports contain a lower percentage of neuroepithelial tumors than the combined western series. Ependymomas, in most reports, are the most common gliomas of the spinal canal, but within the spinal cord, astrocytomas usually outnumber ependy-

TABLE X. Metastatic Tumors.

Tumor Histology and Site of Origin	No. of Cases
carcinoma	
lung	
oat cell carcinoma	2
squamous cell carcinoma	1
poorly differentiated carcinoma	1
prostate	3
nasopharynx (squamous cell carcinoma)	2
choriocarcinoma	2
undetermined primary site	
adenocarcinoma	6
squamous cell carcinoma	1
undifferentiated carcinoma	1
lymphoma	16
leukemia	1
rhabdomyosarcoma	1
undifferentiated sarcoma	1
unclassified cancer	3
total	41

TABLE XI.
Histological subclassification of lymphomas and comparison with that reported from the Mayo Clinic.

Histologic Type	Present Series		Mayo Clinic Series*	
	No.	%	No.	%
Hodgkin's lymphoma	4	25	22	23
non-Hodgkin's lymphoma	12	75	72	77
lymphocytic				
well differentiated	2	12.5	24	26
poorly differentiated	7	44	14	15
histiocytic	1	6	16	17
mixed (histiocytic lymphocytic)	2	12.5	17	18
stem cell	-	-	1	1

* Haddad, et.al. (14)

TABLE XII. Vertebral column tumors.

Type of Tumor	No. of Cases
osteoblastoma	1
osteochondroma or osteoma	1
chondroma	1
chondrosarcoma	1
giant cell tumor	1
Ewing sarcoma	2
myeloma	16
hemangioma	1
fibrosarcoma	1
chordoma	2
aneurysmal bone cyst	3
total	30

momas. Low grade astrocytomas of the cord are much more frequent than glioblastomas. Five of the six astrocytic tumors in the present series were grade I or II astrocytomas (83%), the other was a glioblastoma (17%). These ratios were 77% and 23% respectively in a review of 243 astrocytic tumors of the spinal cord.[17] Low grade astrocytomas of the cord have a male preponderance (four out of five in this series), while anaplastic astrocytomas occur equally in both sexes.[23,33]

One of the 13 intramedullary gliomas in the present series was an oligodendroglioma (7.7%) and of 98 intramedullary gliomas reported from the Mayo Clinic, eight were oligodendrogliomas (8%).

Nerve sheath cell tumors represented 24.5% of the spinal canal tumors in the present series. As considered in Table XIII, the proportion of NSCTs is higher in the eastern reports than in the combined western series, constituting 47% of spinal canal tumors in the Chinese series. However the considerably greater percentage of these tumors in the eastern reports is not noted in the present series. This is partly due to the higher proportion of secondary tumors in the latter. Table XIV compares primary spinal canal tumors in this series with the largest western series of primary spinal canal tumors reported in the literature, that from the Mayo Clinic. Although the two series have dissimilarities in the types of tumors included, the proportion of NSCTs is higher in the present series. These comparisons indicate that NSCTs within the spinal canal have a higher frequency in the eastern hemisphere which is more prominent far eastern countries. Intracranial NSCTs have also been reported to occur more frequently in eastern countries.[18,37]

Males have been reported to develop NSCTs within the spinal canal at a younger age than females. In a report of 44 cases by Broager, et.al.,[25] mean ages for males and females were 41 and 48 years respectively. Salah, et.al.,[30] encountered a similar finding in 47 cases. However this was not the case in the 44 patients in the present series. The men age for males was six years more than that for females (38.6 versus 32.6 years).

While the reports of spinal canal tumors from the East have a higher proportion of NSCTs than the combined western series (Table XIII), the eastern reports, especially those from the far eastern countries contain a lower percentage of meningiomas. However, the proportion of meningiomas in the current series is more similar to that in western reports (Tables XIII and XIV). Interestingly, NSCTs and meningiomas in the Indian material have proportions between those in the far eastern reports and the figures obtained in this study. The ratio of NSCTs to meningiomas varies considerably in different reports of spinal canal tumors. In some western series NSCTs are the most common primary neoplasms while in others meningiomas predominate. The ratio of NSCTs to meningiomas in the collected western series is 1.03/1; this ratio is 1.2/1 in the current series, 1.5/1 in the Indian material and 3.3/1, 4.2/1 and 3.9/1 in the Chinese, Thai and Japanese reports respectively. It is worth stressing that in older age groups, meningiomas usually outnumber NSCTs (Table II).[8,16,33]

In an Australian report, among 61 spinal canal tumors in patients over 65 years of age, there were 13 meningiomas and two NSCTs[16] and in the Mayo Clinic series in patients older than 60 years, there were 75 meningiomas and 46 NSCTs (Table XIV).[33]

Seventeen percent of the meningiomas in the present material were extradural (Table IX). The corresponding percentage in a report from the Cleveland Clinic was 7%[21] and in the Mayo Clinic series 15%.[33] The extradural meningioma, as indicated by the cases in this series, has a different behavior from its intradural counterpart; it occurs at a younger age, tends to be vascular and invasive and has no particular affinity for females or the thoracic region (Table IX).[6,21,24]

Lumbar meningiomas in most reports represented less than 8% of spinal canal meningiomas (2.27% in

TABLE XIII. Relative incidences of spinal canal tumors in several eastern and collected western series.

Tumor Type	West Nittner*		Iran Present Series		India Lalitha		China Wen-qing*		Thailand Shuangshoti		Japan Izumida +	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
neuroepithelial tumors	770	15.7	18	10	68	15.9	255	10.8	11	6.2	61	8.3
nerve sheath cell tumors	1129	23.1	44	24.5	130	30.5	1110	47.1	73	41.7	327	44.9
meningiomas	1088	22.4	36	20.1	83	19.4	331	14	17	9.7	83	11.4
vascular tumors & malformations	318	6.5	4	2.2	19	4.4	106	4.5	2	1.1	45	6.2
congenital tumors	-	-	2	1.1	26	6.1	284	12	2	1.1	26	3.6
secondary tumors	693	14.2	71	39.6	100	23.4	110	4.6	69	39.3	81	11.1
miscellaneous & unclassified tumors	887	18.1	4	2.2	-	-	159	6.7	1	0.5	106	14.5
total	4885		179		426		2355		175		729	

* Compound series collected from various sources.

** In the report of neural neoplasms from Thailand, comprising all age groups, there were 175 adult spinal canal tumors. These were reclassified to be comparable with the other series in this table.

\+ Data obtained from Cheng (8)

this series). Akin to extradural meningiomas, tumors arising in the lumbar canal probably differ in character from usual thoracic intradural neoplasms.[25] The findings in the only patient with lumbar meningioma in this study are evidence of such behavior. He was a 24-year-old man with an intradural angiomatous meningioma invading the dura and extradural space. The tumor recurred 11 years after the first operation.

The issue of the angiomatous meningioma and its relation to the hemangioblastoma and hemangiopericytoma is still a controversial subject. While some consider the latter as subdivisions of the former, others believe that the hemangioblastoma and hemangiopericytoma are distinct pathological entities. The present series included five cases that could be classified as angiomatous meningiomas. Two of these were intradural and exhibited distinct microscopic features of hemangioblastomas which were classified as vascular tumors. Another one, also intradural, had a hemangiopericytic appearance. All three more or less shared some features with meningiomas, indeed an expression of the continuum between these tumors advocated by some investigators.[29] The remaining two of the five were true angiomatous meningiomas with prominent vascularity. Both were in men, with one in the thoracic region epidural in location with invasion of the vertebrae, and the other lumbar and intradural as just described.

In this study vascular tumors and malformations constituted 3.8% of the primary spinal canal tumors and 2.2% of the entire series, lower proportions than those reported in most series of spinal canal tumors (Tables XIII and XIV).

A low frequency of vascular malformations probably accounts for the discrepancy, as vascular tumors (hemangioblastomas) in this material represented 1.9% of the primary spinal canal tumors which is within the range of 1.6 to 3%, the reported relative frequency of spinal canal hemangioblastomas.[39] The low frequency of vascular malformations in the present series probably results from the fact that these hamartomas are more likely to be diagnosed at autopsy[27] whereas the diagnoses in this study were based exclusively on surgical specimens. Indeed not all patients with vascular malformations of the spinal canal might lead to surgery and in those who undergo laminectomy, the biopsy specimen may not reveal the diagnosis. Small malformations damaged due to hemorrhage would not be detectable afterwards, during surgery or microscopic examination. A patient with hematomyelia was operated on in this center in whom the biopsy specimen was suspected to be a vascular hamartoma, although a definite diagnosis could not be made. In another patient with myelomalacia, informative biopsy could not be obtained at the time of laminectomy.

Congenital tumors made up 1% of the spinal canal tumors in the present series (Table XIII). In view of the diversity in the types of tumors included in this category, comparison of the proportion of congenital tumors in the various reported series may not reveal real differences in the frequency of these tumors. The low proportion of congenital tumors in this study is probably due to the exclusion of children in whom these lesions are usually the most common causes of spinal cord compression.

Spinal canal lipomas are either intradural or extradural, the former being more frequent. Guiffre reported six intradural and three extradural lipomas among 387 primay spinal canal tumors (2.3%).[13] The present series included only one intradural lipoma among 104 primary spinal canal tumors (1%), as a high proportion of lipomas occurs in patients younger than

15 years of age. Lipomas in the earlier decades of life are usually in the lumbosacral region, have equal sex distribution and are more commonly associated with congenital anomalies as compared with cervicothoracic lipomas. Patients with these lesions have a mean age in the fourth decade of life and a male preponderance (3/1).[31-35] The intradural lipoma in the present series was in the upper thoracic segments (T1-T4) in a 41-year-old male.

Twenty three percent of the patients in this study had metastatic tumors (Tables I and X). Estimates of the relative frequency of metastatic tumors among spinal canal neoplasms vary widely. The proportion obtained in this study can be compared with that in the Thai and Indian series (Table XIII). Metastatic tumors constituted 30% of 175 adult spinal canal tumors reported from Thailand and 20% of 426 spinal canal neoplasms in the Indian series.

Metastatic tumors of the spinal canal are usually epidural in location. The most common primary malignancy responsible for this condition in large series of spinal epidural metastases is usually in the breast or lung or is a lymphoma depending on whether the series is derived from neurosurgical or oncological units and also on the strategy in a center to treat patients with known cancer who develop paraplegia by surgery or other therapeutic modalities.[7,9,34] Carcinoma of the breast is known to develop spinal metastases long after the neoplasia has been diagnosed.[34] Therefore in the majority of such cases, the diagnosis of the breast carcinoma has already been made at the time of cord compression. Series of spinal canal matastases from oncological units that often deal with patients who are known to harbor malignancy are expected to have a high percentage of breast carcinomas. On the other hand, in a considerable number of patients with epidural metastases of NHL or bronchogenic carcinomas, spinal cord compression is the first manifestation of the neoplasia.[4,14,34] Therefore these tumors are expected to occur more frequently in series of epidural metastases from neurosurgical services that generally deal with undiagnosed patients, as the current series, in which the neoplasia was unknown before laminectomy in 80% of the patients. Table XV compares the most common primary tumors in this material with those in several surgical series. The high proportion of metastases with unknown primary sites in this study results from incomplete follow-up and the lack of postmortem studies that might reveal the primary lesions in a considerable number of these cases.

Certain histologic subtypes of lymphomas have a special propensity to involve the spinal epidural space. Nodular lymphomas rarely deposit in the epidural space[20], and among diffuse lymphomas, lymphocytic lymphoma is the most common subtype. Table XI

TABLE XIV. Relative incidences of primary spinal canal tumors in this study and Mayo Clinic report.

Tumor Type	Present Series		Mayo Clinic Series	
	No.	%	No.	%
neuroepithelial tumors	18	17.3	291	22
nerve sheath cells tumors	44	42.3	383	29
meningiomas	36	34.6	338	25.5
vascular tumors & malformations	4	3.8	82	6.2
congenital tumors	2	1.9	18	1.36
sarcomas	-	-	157	11.87
chordomas	-	-	53	4
total	104		1322	

* Sloof, et. al. (33)

indicates the histologic subtypes of the epidural lymphomas in the present series and in 94 cases reported from the Mayo Clinic.[14] Poorly differentiated lymphocytic lymphoma (PDLL) was the most common subtype in this study and well differentiated lymphocytic lymphoma was the most frequent subtype in the Mayo Clinic report. Other series with a high proportion of PDLL have also been described. Thirteen of 19 patients with epidural NHL reported by Levitt, et.al., had a PDLL.[20]

In this study, spinal cord compression was the first manifestation of the lymphoma in 83% of the patients with NHL but only in 25% of the patients with Hodgkin's disease. Similar findings have been reported from the Mayo Clinic in which the corresponding percentages were 85% and 27% respectively,[14] indicating that in contrast to Hodgkin's disease in which the tumor usually deposits in the epidural space during the course of a recognized lymphoma, epidural NHL tends to represent the first manifestation of the lymphoma.

Male preponderance in this study was more prominent in the patients with metastatic carcinomas (2.8/1) than in those with lymphomas (1.2/1). This male dominancy in metastatic carcinomas is not in accordance with large series of these tumors which usually have variable numbers of breast carcinoma.[7]

Epidural metastatic tumors rarely appear in the cervical canal and the thoracic region is dominant over the lumbar in involvement.[7] This dominancy in the present series was more prominent for the lymphomas than metastatic carcinomas (Table III). Although the number of the patients is admittedly small to warrant any statistically valid conclusion, the discrepancy bespeaks different mechanisms by which these tumors reach the spinal canal. Lymphomas usually involve the epidural space by direct extension from paraspinal lymphoid tissues having a predilection for the midthoracic region, whereas metastatic carcinomas can reach the spinal canal hematogenously or by direct

TABLE XV. surgical series of spinal canal metastases all included lymphoma. Comparison of percentages of four leading primary tumors in several

Authors & Year	No. of Cases	Primary Tumors*			
		First	Second	Third	Fourth
Dunn, et.al., 1980	104	prostate (20)	lung (18.2)	unknown (9.6)	breast (6.7)
Wright, 1963	84	lymphoma (16.6)	breast (15.1)	lung (11.9)	unknown (10.7)
Botterell & Fitzgerald,1959	62	lymphoma (46.7)	prostate (12.9)	unknown (11.2)	kidney (4.8)
Wild & Porter, 1963	43+	lung (25.5)	prostate (13.9)	kidney (11.6)	lymphoma (11.6)
present series	41	lymphoma (39)	unknown (29.2)	lung (9.7)	prostate (7.3)

* Numbers in parentheses are percentages of the entire series.
+ Bone tumors were excluded.

extension. When hematogenous they are evenly distributed up and down the vertebral column, and by direct extension, the tumors may appear in the thoracic or lumbar canal, depending on the primary lesion. Bronchogenic carcinomas have a slight predilection for the upper thoracic region while pelvic tumors appear in the lumbar canal more frequently.[22,3,4] In this study 25% of the patients with lymphomas had evidence of bone involvement; the ratio was 73% for the patients with metastatic carcinomas. Again the discrepancy results from the different routes by which these tumors reach the spinal canal: lymphomas usually spread to the epidural space through the intervertebral foraminae[20] whereas metastatic carcinomas often deposit first in the vertebral body with later extension to the epidural space.[3,4]

In 16.7% of the patients in this study, spinal cord or cauda equina compression was due to vertebral column tumors (Tables I and XII). As a comparison, bone tumors constituted 3.3% of spinal canal neoplasms in the Indian report and approximately 9% of adult spinal canal tumors in the Thai series (Table XIII). The latter contained an additional number of chordomas (5.7% of the total series). The higher proportion of vertebral column tumors in this study is an expression of the excessive frequency of myelomas as well as the different method of case ascertainment. Some of the patients with vertebral column tumors in the current series have been operated by neurosurgeons, other by orthopedic surgeons, but all of them had signs of spinal cord or cauda equina compression when presenting to this general hospital. Certainly, the frequency of associated neurological deficit, when the histological diagnoses of vertebral column tumors are made, depends on whether patients are operated at an early stage when the main symptom is pain, or later in the course of the disease when the tumor has already encroached upon the neural contents of the spinal canal.

The frequency of myelomas in this study was unusually high. They accounted for 53% of the vertebral column tumors (Table XII) and 8.9% of all the spinal canal neoplasms. In an Italian neurosurgical report, there were 18 myelomas among 93 vertebral column tumors (19.3%).[11] Myelomas constituted 2.8% of spinal canal neoplasms in the Indian series and 2.9% of adult spinal canal tumors in the Thai report (Table XIII). The condition usually occurs in patients over forty years of age and males are more commonly affected (11 of the 16 in this series). The neoplasm involves the thoracic area in nearly two-thirds of patients. The lumbar, cervical and sacral regions are next, in descending order of frequency (Table III).[26] In the thoracic spine, the lower half is more frequently affected[26], eight of the 16 myelomas in the present series were in the lower half of the thoracic spine.

One patient in the present series had a vertebral hemangioma (3.5% of the spinal column tumors). The Italian series contained 14 such cases (15%). The frequency of the vertebral hemangioma in this series is probably underestimated, like other vascular hamartomas. Three of the four patients classified as the unknown group were suspected to have these lesions (Table I), two had radiological evidence of hemangiomas but in none could a definite histological diagnosis be made.

Giant cell tumors are infrequent neoplasms of the spinal column; A high proportion of sacral involvement has been reported in some series, especially those in the American literature. Dahlin, et.al. reported 19 sacral with six vertebral tumors from the Mayo Clinic,[10] whereas the Italian series comprised one sacral with five vertebral tumors,[11] and a Swedish report included one sacral and four vertebral tumors.[19] The present material contained only one sacral tumor.

Three patients in the current series had aneurysmal bone cysts (10% of the spinal column tumors): a 23-year-old man with the lesion at the lumbosacral junction (L5-SI), a 24-year-old woman with the lesion in the thoracic region (T5) and a 26-year-old man with the lesion in the lumbar spine (L3). The Italian series comprised seven aneurysmal bone cysts (7.5%). Hay, et.al. reviewed 92 reported cases of vertebral aneurysmal bone cyst. The average age in 81 of these patients

was 16.6 years,[15] More recently Ameli, et.al. Looked at this condition in Iran and presented 17 cases with a mean age of 20.5 years.[2]

Of the 92 patients reviewed by Hay, et.al. the lesions were cervical in 22%, thoracic in 34%, lumbar in 31% and sacral in 13%. However eight of the 17 cases reported by Ameli, et.al. had cervical aneurysmal bone cysts.

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REFERENCES

1. Alter M: Statistical aspects of spinal cord tumors. In: Vinken PJ, Bruyn GW (eds): Tumours of the Spine and Spinal Cord. Part I. Handbook of Clinical Neurology, Vol 19. Amsterdam: North-Holland, 1-22, 1975.
2. Ameli NO, Abhassioun K, Saleh H, et al: Aneurysmal bone cysts of the spine. Report of 17 cases. J Neurosurg 63:685-90, 1985.
3. Botterell EH, Fitzgerald GW: Spinal cord compression produced by extradural malignant tumors. Early recognition, treatment and results. Can Med Assoc J 80: 791-6, 1959.
4. Boyle R, Thomas M, Adams H: Diffuse involvement of the leptomeninges by tumor-a clinical and pthological study of 63 cases. Postgraduate Medical Journal 56:149-58, 1980.
5. Burger PC, Vogel FS: Surgical Pathology of the Nervous System and its Coverings. New York: John Willey & Sons, 1982.
6. Calogero JA, Moossy J: Extradural spinal meningiomas. Report of four cases. J Neurosurg 37:442-7, 1972.
7. Chade HO: Metastatic tumors of the spine and spinal cord. In: Vinken PJ, Bruyn GW (eds): Tumours of the Spine and Spinal Cord. Part II. Handbook of Clinical Neurology, Vol20. Amsterdam: North-Holland, 415-33, 1975.
8. Cheng MK: Spinal cord tumors in the People's Republic of China: A statistical review. Neurosurgery 10:22-4, 1982.
9. Constans JP, Divitiis E, Donzelli R, et al: Spinal metastases with neurological manifestations. Review of 600 cases. J Neurosurg 59:111-118, 1983.
10. Dahlin DC, Cupps RE, Johnson EW: Giant-cell tumor: a study of 195 cases. Cancer 25:1061-70, 1970.
11. DiLorenzo N, Spallone A, Nolletti A, et al: Giant cell tumors of the spine: a clinical study of six cases, with emphasis on the radiological features, treatment, and follow-up. Neurosurgery 6:29-34, 1980.
12. Dunn R, Kelly WA, Wohns RNW, et al: Spinal epidural neoplasia. A 15-year review of the results of surgical therapy. J Neurosurg 52:47-51, 1980.
13. Giuffré R: Spinal lipomas. In: Vinken PJ, Bruyn GW (eds): Tumours of the Spine and Spinal Cord, Part II. Handbook of Clinical Neurology, vol 20. Amsterdam: 389-414, 1975.
14. Haddad P, Thaell JF, Kiely JM, et al: Lymphoma of the spinal extradural space. Cancer 38:1862-6, 1976.
15. Hay MC, Paterson D, Taylor TKF: Aneurysmal bone cysts of the spine. J Bone Joint Surg 60:406-11, 1978.
16. Huang CY, Matheson J: Spinal cord tumours in the elderly. Aust N Z J Med 9:538-41, 1979.
17. Kopelson G, Linggood RM: Intramedullary spinal cord astrocytoma versus glioblastoma. The prognostic importance of histologic grade. Cancer 50:732-5, 1982.
18. Lalitha VS, Dastur DK: Neoplasms of the central nervous system-Histological types in 2237 cases. Indian J Cancer 17: 102-6, 1980.
19. Larsson SE, Lorentzon R, Boquist L: Giant-cell tumors of the spine and sacrum causing neurological symptoms. Clin Orthop 111:201-11, 1975.
20. Levitt LJ, Dawson DM, Rosenthal DS, et al: CNS involvement in the non-Hodgkin's lymphomas. Cancer 45:545-52, 1980.
21. Levy WJ, Bay J, Dohn D: Spinal cord meningioma. J Neurosurg 57:804-12, 1982.
22. Mercier PH, Vialle M, George B, et al: Les métastases rachidiennes intradurales des cancers vicéraux. A propos de 4 cas. Neurochirurgie 30:177-81, 1984.
23. Mortara R, Parker JC, Brooks WH: Glioblastoma multiforme of the spinal cord. Surg Neurol 2:115-9, 1974.
24. Muller JP, Destée A, Verier A, et al: Les hémangiopéricytomes intrarachidiennes. Deux observations et revue de la litterature. Neurochirurgie 32:140-6, 1986.
25. Nittner K: Spinal meningiomas, neurinomas, and neurofibromas and hourglass tumours, In: Vinken PJ, Bruyn GW (eds): Tumours of the Spine and Spinal Cord, Part II. Handbook of Clinical Neurology, vol 20. Amsterdam, 177-322, 1975.
26. Onofrio BM, Svien HJ: Solitary and multiple vertebral myelomas. In: Vinken PJ, Bruyn GW (eds): Tumors of the Spine and Spinal Cord, Part II. Handbook of Clinical Neurology, vol20. Amsterdam, 9-18, 1975.
27. Percy AK, Elveback LR, Okazaki H, et al: Neoplasms of the central nervous system. Epidemiologic considerations. Neurology 22:40-8, 1972.
28. Rappaport H: Tumors of the hematopoietic system. In: Atlas of Tumor Pathology, sec 3, fase 8. Washington, DC: Armed Forces Institute of Pathology, 1966.
29. Russell DS, Rubinstein LJ: Pathology of Tumours of the Nervous System. Baltimore: Williams & Wilkins, 4th ed, 1977.
30. Salah S, Horcajada J, Perneczky A: Spinal neurinomas-A comprehensive clinical and statistical study on 47 cases. Neurochirurgia (Stuttg) 18:77-84, 1975.
31. Scherpereel B, Richard O, Carter DD, et al: Compression médullaire lente par lipome intra-dural cervical. Neurochirurgie 30:51-4, 1984.
32. Shuangshoti S, Panyathanya R: Neural neoplasms in Thailand: a study of 2,897 cases. Neurology 24:1127-34, 1974.
33. Sloof JL, Kernohan JW, MacCarty CS: Primary Intramedullary Tumors of the Spinal Cord and Filum Terminale. Philadelphia: WB Saunders, 1964.
34. Stark RJ, Henson RA, Evans SJW: Spinal metastases. A retrospective survey from a general hospital. Brain 105: 189-213, 1982.
35. Thomas JE, Miller RH: Lipomatous tumors of the spinal canal. A study of their clinical range. Mayo Clinic Proc 48:393-400, 1973.
36. Törmä T: Benign osteogenic and chondrogenic tumours of the spine. In: Vinken PJ, Bruyn GW (eds): Tumours of the Spine and Spinal Cord, Part I. Handbook of Clinical Neurology, Vol 19. Amsterdam, 293-312, 1975.
37. Wen-qing H, Shi-ju Z, Qing-sheng T, et al: Statistical analysis of central nervous system tumors in China. J Neurosurg 56:555-64, 1982.
38. Wild WO, Porter RW: Metastatic epidural tumors of the spine. A study of 45 cases. Arch Surg 87:825-30, 1963.
39. Wisoff HS, Suzuki Y, Llena JF, et al: Extramedullary hemangioblastoma of the spinal cord. Case report. J Neurosurg 48:461-4, 1978.
40. Wood EH, Taveras JM, Pool JL: Myelographic demonstration of spinal cord metastases from primary brain tumors. AJR 96:221-30, 1953.
41. Wright RL: Malignant tumors in the spinal extradural space: results of the surgical treatment. Ann Surg 157:227-31, 1963.