Primary Intraplasmal Tumors in China: A Consecutive Surgical Series of 589 Patients

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Abstract

Purpose: Primary intraspinal tumors are rare tumors of the central nervous system. There is a paucity of detailed clinical data on the tumors for neurosurgeons. The paper is to report the clinical characters of 589 patients with primary intraspinal tumors in China.

Methods: Medical records of 589 patients with primary intraspinal tumor treated surgically with pathologic confirmation from January 2015 to December 2019 in our hospital were collected and reviewed. In each case, data about patient's age at surgery, sex, clinical presentation, anatomical location, vertebral levels and histological diagnosis were obtained and analyzed.

Results: The entire cohort included 281 (47.7%) males and 308 (52.3%) females with a mean age of 48.1 years. Primary intraspinal tumors were most likely occurred on thoracic levels, counting 38.7%, compared with cervical 25.1% and lumbar 33.7%. 80.3% (472/589) of intraspinal tumors were intradural extramedullary, and 5.60% (33/589) were intramedullary, and 13.07% (77/589) were epidural. The pathological diagnoses included schwannoma (52.8%), meningioma (10.4%), cyst (8.0%), teratoma (24.4.1%), ependymoma (23.3.9%), and angioma (23.3.9%), and females had a higher incidence of meningiomas than males, with a male/female of 0.20. Pain, numbness, weakness, and sensory disturbances were most common presentations of the intraspinal tumor, which was determined partially by the vertebral level distribution and anatomical location.

Conclusions: This large single-center clinical study adds new insights into the descriptive epidemiology and characters of primary intraspinal tumors by providing in-depth analyses of these tumors, which is of vital importance in planning studies on prevention, diagnosis, treatment, and prognosis of the tumors.

Introduction

Primary intraspinal tumors are one of the rarest categories of tumors, overall incidence rate of which was 0.4 to 1.5 per 100 000 person-years,[1, 2] representing about 2-4% of all tumors arising from the central nervous systems (CNS). [3–7]

Although there are several investigations on the epidemiology of intraspinal tumors from different countries, the frequencies of different intraspinal tumors vary among these published reports.[5] Moreover, the occurrence and distribution of intraspinal tumors by sex, age, and pathology vary among races and regions. [6, 8, 9] As far as we know, there is still no investigation published in the English literature which focuses on the epidemiology and characters of intraspinal tumors in China in the last decades, and there is a paucity of population-based data on primary intraspinal tumor incidence, clinical presentation, histology.

The epidemiological investigations on the incidence, anatomical distribution and presentations of the intraspinal tumors, and further analysis of the age and sex of the patients are of vital importance in planning studies on prevention, diagnosis, treatment, and prognosis of the tumor.[4, 10–12] [13, 14] The rarity of these data has significant ramifications on patient outcomes, as it limits the level of research, treatment decisions, and health care planning. As a result, large population-based data sources are needed to provide accurate descriptive statistics on primary intraspinal tumors.

In this retrospective study, we reviewed the consecutive cases with primary intraspinal tumors treated surgically in our hospital, to objectively clarify the demographics, symptoms and signs, histological types in Chinese patients. Furthermore, we investigated the relation between the histological types, clinical presentation and age, sex, histological type, anatomical location and vertebral level distributions. Thirdly, we described features of spinal cord tumors in Chinese people, and demonstrated the similarities and differences of intraspinal tumors in populations from other countries, suggesting the role races and regions may play in the etiology of intraspinal tumors.

Methods And Materials

The study protocol was authorized by Ethical Committee of Qilu hospital Shandong University.

Patients

We collected details of consecutive patients with intraspinal tumors treated surgically in the department of orthopedic and neurosurgery of Qilu hospital between January 2015 and December 2019. All cases were histologically confirmed by neuropathologists. Of the material collected, all duplicates have been excluded. Cases with metastatic tumors and primary bone tumors were excluded.

Data Collection

In each case, data about the patient's age at surgery, sex, initial clinical presentation, anatomical location of the tumor, vertebral levels and histological diagnosis were obtained and analyzed.

Statistical analysis

We investigated the relation between the histological types, clinical presentation and age, sex, histological type, anatomical location and vertebral level distributions, and compared the results of our study with other studies performed elsewhere in the world.

Results

Patient demographics

There were 589 patients with primary intraspinal tumors were incorporated into the study. Of the 589 patients, 281 patients (47.7%) were male and 308 patients (52.3%) were female, for which the male/female ratio was 0.91/1. The mean age at surgery was 48.1 year (range from 9 month to 84 years). As shown in the Figure 1A, the patient groups aged 50–59 years encompassed the largest number of patients with primary intraspinal tumors when the patients were stratified by age in 10-year intervals. Only 5.1% (30 patients) of patients were under 20 years of age and 0.8% (5 patients) of the patients were beyond 80 years of age.

Medical history and clinical presentation

The 589 patients had no obvious exposures to the carcinogenic factors (radiation, chemical et al) in the investigation. As shown in the Table S1, hypertension was considered as the most common coexisting medical condition, counting for 19.3% of patients, followed by diabetes (5.6%), cardiovascular disease (4.2%) and cerebrovascular disease (1.4%). The medical history of the patients, including history of cancer or tumor, is shown in Table S1. Uterine fibroids, lung tumor and intracranial tumors were the most prior tumor. As expected, the older patients were responsible for relatively higher percentage of patients with hypertension, diabetes, and other prior tumors.

The clinical presentation of primary intraspinal tumors was shown in Table 1. Over all, pain and numbness were most common symptom, followed by weakness, difficulty with coordination or balance, and urinary/fecal incontinence. The pain included focal pain and radicular pain due to the distributions and locations of the intraspinal tumors. Meanwhile, the most common signs of the intraspinal tumors were weakness and decreased sensation, followed by pathological reflexes, tendon reflex, patellar/ankle clonus and abnormal gait. Urinary and fecal incontinence were observed in 43 patients with intraspinal tumors, and 12 patients developed quadriplegia or paraplegia.

Table 1
Clinical presentation of primary intraspinal tumors according to vertebral level distribution
subgroup n(%)*

Clinical presentation	Cervical	Thoracic	Lumbar	Sacral	All
Symptoms					
Pain	68(46.0)	127(55.7)	167(84.3)	12(80.0)	374(63.5)
Numbness	77(52.0)	124(54.4)	45(22.7)	3(20.0)	249(42.3)
Weakness	56(37.8)	81(35.5)	25(12.6)	0	162(27.5)
Coordination and balance	48(32.4)	42(18.4)	8(4.0)	0	98(16.6)
Urinary/fecal incontinence	4(2.7)	17(7.5)	20(10.1)	2(13.3)	43(7.3)
Signs					
Weakness	72(48.6)	114(50.0)	71(35.9)	3(20.0)	260(44.1)
Sensation loss	52(35.1)	95(41.7)	48(24.2)	4(26.7)	199(33.8)
Gait abnormality	5(3.4)	7(3.1)	6(3.0)	0	18(3.1)
Tendon reflex (in or de)	16(10.8)	36(15.8)	20(10.1)	4(26.7)	76(12.9)
Pathological reflexes	29(19.6)	40(17.5)	8(4.0)	0	77(13.0)
Patellar/ankle clonus	5(3.4)	6(2.6)	2(1.0)	0	13(2.2)
Muscular tension (in or de)	5(3.4)	7(3.1)	1(0.5)	0	13(2.2)
*Number and percentage Abbreviations: de=decreased in=increased					

The symptoms and signs of the intraspinal tumor patients were further analyzed according to the vertebral level distribution and anatomical location of the tumors. As shown in Table S2-S5, the pain and urinary/fecal incontinence were most frequently occurred in lumbar intraspinal tumor, followed by thoracic and cervical intraspinal tumor. And on the contrary, the frequency of numbness, weakness and difficulty with coordination or balance in cervical and thoracic was higher than that of lumbar. It is the same with the signs, which were more common presented in cervical and thoracic intraspinal tumors than lumbar.

The lengths of symptoms, showed in Figure S1, were investigated meticulously according to the pathological types, patient age, anatomical and vertebral distributions.

Vertebral level distribution

As shown in Figure S2, the vertebral levels distribution of the tumors was evenly distributed. Primary intraspinal tumors were most likely occur on the thoracic levels, counting 38.7% (228/589) of the intraspinal tumor compared with the cervical 25.1% (148/589) and lumbar 33.7%(198/589). The age distribution of the cervical, thoracic and lumbar were shown in Figure 1B,1C,1D separately. The patient groups aged 50-59 years comprised the largest number of patients with primary cervical, thoracic and lumbar intraspinal tumors. The male/female ratio was 1:1 in cervical, 0.57:1 in thoracic and 1.10:1 in lumbar.

Anatomical location

Of 589 patients, as shown in the Figure S3, 80.3% (472/589) of the intraspinal tumors were intradural extramedullary, and 5.60% (33/589) were intramedullary, and 13.07% (77/589) were epidural. The remainder 1.1% (6/589) were intra-epidural tumors. The age distribution of the primary intraspinal tumors based on the anatomical distributions (Figure 1E-1G) were investigated separately. The location of intraspinal tumors in cervical, thoracic and lumbar were also investigated separately. As shown in the Table 2, the location distribution of the intraspinal tumors in cervical levels was consistent with that of thoracic levels, and slightly different from that of lumbar levels. The intradural extramedullary tumors in lumbar level (88.89%) was higher than that of cervical (75.68%) and thoracic level (75.44%). While, the epidural tumors in lumbar level (6.57%) were lower than that of cervical (15.54%) and thoracic level (17.11%).

Table 2
Anatomical locations and vertebral level distribution of primary intraspinal tumors

	Cervical				Thoracic				Lumbar				Sacral				All
	Male	Female	All	M/F	Male	Female	All	M/F	Male	Female	All	M/F	Male	Female	All	M/F	
Intradural extramedullary	55	57	112	0.96	66	106	172	0.62	92	84	176	1.09	5	7	12	0.74	21
Intramedullary	5	3	8	1.66	12	4	16	3.0	5	4	9	1.25	0	0	0	0	22
Epidural	11	12	23	0.91	19	20	39	0.95	7	6	13	1.17	1	2	3	0.5	38
Intra-epidural	3	2	5	1.50	0	1	1	0	0	0	0	0	0	0	0	0	3
total	74	74	148	1.00	97	131	228	0.74	104	94	198	1.10	6	9	15	0.67	28

The vertebral levels of the intradural extramedullary tumors, intramedullary tumors and epidural tumors were evenly distributed (Table 2). The intradural extramedullary tumors developed predominantly in thoracic and lumbar levels, and the epidural tumors occurred more frequently in the cervical and thoracic levels.

Histological type of tumors

The pathological diagnoses of the primary spinal cord tumors are shown in Table 3. Of the 589 patients, the most common tumor types were schwannomas (311,52.8%), meningioma (61,10.4%), cyst (47,8.0%), teratoma (24,4.1%), ependymoma (23,3.9%), and angioma (23,3.9%). Based on histological characteristics, the tumors were categorized as benign in 548 cases (93.0%), malignant in 41cases (7.0%). Further analysis of tumor histological types stratified by patient sex and age exhibited that among patients with meningioma (61 cases), 51cases (83.6%) were female and 10 cases (16.3%) were male, with a ratio of 5:1 ($p < 0.001$). Neurofibroma showed a 2.3:1 female / male ratio. Meanwhile teratoma and ependymoma showed a 1.6:1 male/female and 1.8:1 ratio respectively, indicating a slight male predominance. There were 34 patients aged 0-20 years, consisting of schwannomas (13, 38.2%), cyst (7, 20.6%), teratoma (4, 11.8%), lipoma (4, 11.8%), while the following histological types were involved in children of this age: embryonal carcinoma, osteoblastoma. In 26 patients, multiple intraspinal tumors were identified, and1 patient was diagnosed as schwannomas, co-existence with meningioma together.

Table 3
Histological type of 589 primary intraspinal tumors

Histology	Male n	Female n	All n (%)	M/F
Schwannomas	152	159	311(52.8)	0.96
Meningioma	10	51	61(10.4)	0.20
Neurofibroma	4	9	13(2.2)	0.44
Ependymoma	15	8	23(4.0)	1.88
Teratoma	15	9	24(4.1)	1.67
Angioma	14	9	23(3.9)	1.56
Cyst	17	14	31(5.2)	1.21
Epidermoid cyst	10	6	16(2.7)	1.67
Other malignant	3	5	8(1.4)	0.60
Chordoma	1	3	4(0.7)	0.33
Lipoma	5	6	11(1.9)	0.83
Paraganglioma	2	1	3(0.5)	2.0
Primitive neuroectodermal tumor	0	3	3(0.5)	0
Lymphocytoma	1	2	3(0.5)	0.50
Other	32	23	55(9.3)	1.39
Total	281	308	589(100)	0.91

We further investigated the tumor histological types stratified by patient age in 5-year intervals, and found distinct peaks in the frequency of intraspinal tumors (Figure 1H-1M). schwannomas and meningiomas more commonly were found in middle-aged patients, with a peak of frequency at 50-55 years interval. No patient aged 0-20 was diagnosed as ependymoma. The cyst and teratoma were more common in young patients, with a peak frequency at 30-35,35-40 years intervals respectively, while ependymoma were found in middle-aged and older patients.

Histological type of 589 primary intraspinal tumors according to the vertebral level distribution and anatomical location were further analyzed (Table 4).

Table 4

Histological type of 589 primary intraspinal tumors, according to the vertebral level distribution and anatomical location

	Cervical				Thoracic				Lumbar				Sacral			
	Male	Female	All	M/F	Male	Female	All	M/F	Male	Female	All	M/F	Male	Female	All	M/F
Intramedullary tumors																
Ependymoma	3	0	3	-	5	2	7	2.5	0	2	2	-				
Teratoma					3	0	3	-	2	0	2	-				
Cyst					2	0	2	-	1	2	3	0.5				
Lipoma	0	1	1	-	0	1	1	-	1	0	1	-				
Angioma	0	1	1	-												
Astrocytoma	1	0	1	-												
Neurofibroma	1	0	1	-												
Malignant tumor					1	1	2	1.0								
Other	0	1	1	-	1	0	1	-	1	0	1	-				
Total	5	3	8	1.67	12	4	16	3.0	5	4	9	1.25				
Intradural Extramedullary tumors																
Schwannomas	44	38	82	1.16	44	54	98	0.81	49	45	94	1.09	1	4	5	0.25
Meningioma	3	8	11	0.38	7	38	45	0.18	0	5	5	-				
Cyst	2	3	5	0.67	5	3	8	1.67	15	9	24	1.67	1	0	1	-
Teratoma	0	1	1	-	3	0	3	-	6	8	14	0.75	1	0	1	-
Neurofibroma	1	3	4	0.33	0	4	4	-	1	1	2	1.0				
Ependymoma	3	0	3	-	1	0	1	-	3	4	7	0.75				
Angioma	1	1	2	1.0	4	1	5	1.5	1	1	2	1.0				
Lipoma									3	3	6	1.0	1	0	1	-
Primitive neuroectodermal tumor									0	3	3	-				
Malignant tumor	0	1	1	-	1	1	2	1.0								
Chordoma					0	1	1	-					0	1	1	-
Paraganglioma									0	1	1	-				
Other	1	2	3	0.5	1	4	5	1.6	14	4	17	4.6	1	2	3	0.5
Total	55	57	112	0.96	66	106	172	0.62	92	84	176	1.09	5	7	12	0.71
Epidural tumors																
Schwannomas	3	5	8	0.60	10	5	15	2.0	1	2	3	0.5	1	2	3	0.5
Neurofibroma	1	0	1	-	0	1	1	-								
Angioma	2	1	3	2.0	4	4	8	1.0	2	0	2	-				
Lymphocytoma	0	1	1	-	1	1	2	1.0								
Chordoma	1	0	1	-	0	1	1	-								
Cyst					1	3	4	0.33								
Malignant					1	2	3	0.50								
Lipoma									0	1	1	-				
Other	4	5	9	0.80	2	3	5	1.67	4	3	7	1.33				

	Cervical				Thoracic				Lumbar				Sacral			
Total	11	12	23	0.92	19	20	39	0.95	7	6	13	1.17	1	2	3	0.5
Intra-epidural																
Schwannomas	0	2	2	-	0	1	1	-								
Ganglioneuroma	2	0	2	-												
Malignant	1	0	1	-												
Total	3	2	5	1.5	0	1	1	-								

Cervical intraspinal tumor

For 148 cervical patients with intraspinal tumor, 30 cases were involved in the C1-2 levels, 95 cases were involved in the C3-6 levels, 23 were involved in the C7-T1 levels. In 9 patients, multiple intraspinal tumors were identified. In 44 patients, dumbbell intraspinal tumors were extended through the intervertebral foramen. For the histological analysis, the most common tumor types were schwannomas (90,60.8%), meningioma (11,7.4%), neurofibroma (8,5.4%) and ependymoma (6, 4.1%). Further analysis of the 90 schwannomas cases revealed that 80 intraspinal tumors were intradural extramedullary, 8 cases were epidural and the remaining 2 cases were intra-epidural tumors. 26 schwannomas cases were involved in the intervertebral foramen and 4 cases were observed multiplely.

Thoracic intraspinal tumor

Of 228 thoracic patients with intraspinal tumor, 63 cases were involved in the T12-L1 levels, and 165 cases were involved in the thoracic levels. In 8 patients, multiple intraspinal tumors were identified. In 24 patients, dumbbell intraspinal tumors were extended through the intervertebral foramen. For the histological analysis, the most common tumor types were schwannomas (115, 50.4%), meningioma (45, 19.7%), neurofibroma (5, 2.2%), angioma (13,5.7%), teratoma (6, 2.6%) and ependymoma (8, 3.5%). Of 228 intraspinal tumor, 172 cases (75.4%) were intradural extramedullary, and 17 cases were intramedullary, 39 cases were epidural, and 1 case was intra-epidural tumors. Of the 172 intradural extramedullary intraspinal tumor, the most common tumor histological types were schwannomas (98, 57.0%), meningioma (45, 26.2%), neurofibroma (4, 2.3%), angioma (4,2.3%), teratoma (3, 2.6%) and ependymoma (8, 3.5%), and bronchial cyst (3,1.7). Of the 39 epidural intraspinal tumor, the most common histological tumor types were schwannomas (15, 38.5%), angioma (7,17.9%), epidermal cyst (2, 5.1%), lymphocytoma (2, 5.1%). Of the 17 intramedullary intraspinal tumors, the most common histological tumor types were ependymoma (7, 41.2%) and teratoma (3, 17.6%), followed by lipoma (1,5.9%), epidermal cyst (2,11.8%) and malignant tumor (3,17.6%).

Lumbar intraspinal tumor

Of 198 lumbar patients with intraspinal tumor, 20 cases were involved in the L5-S1 levels, and 178 cases were involved in the lumbar levels. In 9 patients, multiple intraspinal tumors were identified. In 20 patients, dumbbell intraspinal tumors were extended through the intervertebral foramen. For the histological analysis, the most common tumor types were schwannomas (97, 49.0%), cyst (27,13.6%), meningioma (5, 2.5%), teratoma (16, 8.1%), ependymoma (9, 4.5%), and lipoma (8, 4.0%). Of 198 intraspinal tumor, 176 cases (88.9%) were intradural extramedullary, and 9 cases (4.5%) were intramedullary, and 13 cases (4.5%) were epidural. The historical types of the intradural extramedullary, intramedullary and epidural subgroup were investigated (Table 4).

Discussion

Intraspinal tumors are uncommon lesions but may cause significant morbidity and mortality. [15] The clinical presentations are consisted of pain, gait disturbances, and radicular neurological symptoms. The epidemiological investigations, anatomical distribution and presentations of the intraspinal tumors, and further analysis of the age and sex of the patients are of vital importance on prevention, diagnosis, treatment, and prognosis of the tumor. Our study evaluated one of the largest single-center study and provided the most detailed series of cases of the primary intraspinal tumors to date, and it was the first data from Chinese detailed in the English literature in the last decades. Our further analyses added new insights into the descriptive characters of primary spinal tumors and provided a more complete understanding of these tumors.

Many investigations on incidence of intraspinal tumors were carried out all over the world. Linh M. Duong [9] identified 11712 cases with the help of the population-based cancer registries database, which covers approximately 96% of the US population, showing the overall incidence rate of intraspinal tumor was 0.27 per 100,000 persons in children (0-19 years) and 1.27 per 100,000 persons in adults. Schellinger [2] found the overall incidence of spinal cord tumors was 0.74 per 100,000 person-years, with an incidence of 0.77/100,000 in females and 0.70/100,000 in males, by analysis 3226 cases from the CBTRUS collaborating state cancer registries, which covers approximately 30% of the US population. Similar result was found in other western countries, such as France (1.2 per 100,000),[16] Estonian study (0.8 per 100,000), [17] Korea study (1.08 per 100,000). [18] Sample size, population races differences and regions may explain differences. Moreover, the incidence rates were lowest in children aged 0 to 19 years and highest in adults aged 75 to 84 years[2]. Likewise, similar age-specific rate patterns were also found in South Korea[18–20] and Estonia[17]. Camille Pouchieu[21] demonstrated increased incidence of overall CNS tumors from 2000 to 2012. The increased incidence rate of CNS tumors was more pronounced in female and in older patients even though the incidence rate increased in all age groups.

The incidence of primary intraspinal tumors in various series are listed in Table 5. Compared with results from other parts of the world, evident differences are presented in the frequencies of schwannomas, meningiomas, ependymoma, angioma, teratoma and cyst. The highest incidence of schwannomas was 57.2% reported in Japan, [22] followed by our 52.8%. As for Chinese, [23, 24] the incidence of schwannomas was ranged from 46.8–52.8%, which was much higher than that of Taiwan. [25, 26] The lowest incidence of schwannomas was 10.8% in Norway[27]. The incidence of schwannomas in Asian countries, including our present report, is much higher than that of western countries. However, the opposite conclusion was drawn in the meningiomas and ependymoma. The incidence of meningiomas in western countries was much higher than that of Asian countries. Moreover, schwannomas was the most common intraspinal tumor in Asian countries, while meningiomas was considered as the most common intraspinal tumor in western countries.[28] Ependymoma presented less frequently in Asian countries than in western countries.[29] The frequency of angioma, teratoma and cyst varied less among countries studied. Possible explanations for the differences may be attributed to small sample size or population races and regions differences.

Table 5
Incidence of primary spinal cord tumors by series from different countries

Country	References	No. of cases	Date	M/F	Schwannomas	Meningioma	Cyst	Teratoma	Ependymoma	Angioma
USA	Schellinger[2]	3226	1998-2002	58%:42%	24.4	28.9				
USA	Preston Martin [30]	462	1972-1985	40%:60%	22.3	42.9				
USA	Engelhard[11]	430	2010	47%:53%	21.2	24.4	1.9		23.7	1.6
USA	Duong[9]	11712	2004-2007	41%:59%	26.7	32.6			21.2	2.3
Norway	Helseth[27]	415	1989	37%:63%	10.8	46.7			18.6	4.1
Norway	Clemens Weber[1]	1104	1993-2011	42%:58%	40	26			17	2
Denmark	Ivona Nemeiko [34]	279	2010-2015	47%:53%	21.9	13.6	0.72	0.36	9.3	
Korea	Yeon Lim Suh [20]	151	1997-1998	46%:54%	37.1	23.8	2.6		11.9	6
Korea	Kyu Won Jung(18)	3312	2006-2010	47%:53%	41.3	20.1			7.6	2.3
Thailand	Shuangsh [31]	197	1956-1973		34.5	8.6			2.5	0.5
Japan	Kenichi Hirano [22]	678	2000-2009	55.6%:44.4%	57.2	11.7			8	7.4
Japan	Hiroshi Ozawa [8]	112	2008-2010	54%:46%	56.0	13			7	
China	Man-Kai Cheng [23]	1639	1950-1976	62%:38%	46.8	12.4				6
China	Huang [24]	2603	1962-1982	60%:40%	47.13	14.06	1.6	7.97	3.96	4.5
Taiwan, China	Yu Lun Wu [25]	184	2002-2013	52.7%:47.3%	29.9	8.7			3.3	2.7
Taiwan, China	Yu Feng Su [26]	117	1999-2004	59%:41%	28.2	12.0	2.6		5.1	
China	OUR	589	2015-2019	47.7%:52.3%	52.8	10.4	8.0	4.0	3.9	3.9

Differences in incidence of intraspinal tumors by sexes varies among different countries, as shown in Table 5. Briefly, in western countries intraspinal tumors predominantly occur in female,[11, 30] whereas they predominantly occur in male in Asian countries.[20, 22, 24, 31] However, females have a predominance over male in our current study, which is consistent with western countries. Furthermore, females have a higher incidence rate of meningiomas than males, with a male/female of 0.20 in our study. The female preponderance for meningiomas is universal in all the previous reports. [32, 33] It is recognized that females have a higher incidence rate of spinal cord tumors than males, primarily due to a higher incidence of meningiomas.[11] Our series confirmed that there would be a male preponderance of primary intraspinal tumors if meningiomas were not included. Males had equal or higher incidence rates of schwannoma, ependymoma, and teratoma than females.

Intraspinal tumor are classified as intramedullary, intradural extramedullary, or epidural and intra-epidural based on the tumor anatomic origin sites. In our study, the most common site of intraspinal tumors was the intradural extramedullary (85.9%), followed by epidural (13.2%), intramedullary (0.5%) and intra-extradural (1.0%). There was male preponderance in intramedullary and female preponderance in intradural extramedullary, with the male/female of 2 and 0.85 respectively. Studies in the United States reported the intradural intramedullary spinal cord tumors constitute 20–30% of all primary spinal cord tumors;

the remaining 70–80% are intradural extramedullary.^[4] A Danish study by Ivona Nemeiko et al[34] demonstrated 25 extradural (15%), 100 intradural extramedullary (60%) and 41 intramedullary tumors (25%). In Thailand, the frequencies of intradural extramedullary, extradural and intramedullary was 52, 39, and 9 percent, respectively.[31] Kenichi Hirano et al[22] found there were 124 patients (18.3%) with intramedullary tumors, 371 patients (54.7%), with intradural extramedullary tumors, 27 patients (4.0%) with epidural tumors, and 155 patients (22.9%) with dumbbell tumors. Most intradural intramedullary tumors are ependymomas, teratoma and lipoma. Intradural extramedullary tumors predominantly comprise either schwannomas or meningiomas, followed by cyst, teratoma and Ependymoma. As for epidural tumors, schwannoma was most common history types, followed by angioma and cyst.

Pain, numbness, weakness, and sensory disturbances have been found to be the most frequent presenting symptoms and signs in patients with intraspinal tumors.[4, 11, 12, 34–36] Pain, manifested as back pain, radicular pain, or central pain, is the most common symptom regardless of location. [37] The patients with extradural intraspinal tumors are more likely to present radicular pain in limbs. Differences of the frequencies of the symptoms were report in the previous studies. Alvina A. Acquaye[38] demonstrated that the most commonly reported symptoms were numbness (67%), pain (58%), and weakness (51%) for intraspinal tumor patients. Vona Nemeiko [34] et al found pain (71%) and sensory deficits (56%) were more common than motor deficits (40%) and urinary/fecal incontinence (20%). Yu-Feng Su [25] et al reported the most common clinical presentation was weakness (55.4%), pain (37.5%), sensory deficit (44.6%) and paralysis (16.1%), and the clinical presentation was related to the pathologic classifications. Engelhard et al[11] reported the most common symptoms were pain (52.2%) and weakness (52.0%), followed by numbness (45.9%), difficulty with coordination and/or balance (26.5%) and urinary incontinence (13.0%). Raco et al[39] showed pain (72.0%), motor (72%), sensory (39%), or sphincter disturbance (15%) were the common symptoms. The clinical presentation of primary intraspinal tumors is determined partially by the vertebral level distribution and anatomical location.[4] In our study, symptoms of spinal cord compression, such as numbness, weakness, coordination and balance disturbance, and sensation deficit, were more likely occurred in patients with intraspinal tumors located in the cervical and thoracic. Meanwhile, symptoms of nerve compression such as pain, urinary/fecal incontinence were more likely occurred in patients with intraspinal tumors located in the lumbar. Early recognition of the signs and symptoms of primary spinal cord tumors facilitates early treatment, potentially minimizes neurologic morbidity, and improves outcome.

There were potential limitations in the study, foremost of which is the relatively small sample size. It was a single center non-population-based study, and we only collected consecutive patients with intraspinal tumors treated surgically, which could not reflect the actual frequency of intraspinal tumors within the Chinese population. Moreover, asymptomatic cases, missed diagnosis and misdiagnosis cases and cases treated conservatively were not investigated in the study. It is urgency to construct China Central Cancer Registry for better analysis the epidemiology and characters of the intraspinal tumors.

Conclusion

This study represents a largest single-center study attempt to concurrently evaluate the demographics, symptoms and signs, histological types in Chinese patients and demonstrates the similarities and differences of intraspinal tumors in populations from other countries. Some of the results confirm or expand upon those in the literature, while others represent new information. Data represents the characteristics of intraspinal tumors, and can be used to gain a better understanding of these tumors. They are of vital importance in planning studies on prevention, diagnosis, treatment, and prognosis of the tumor.

Declarations

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Availability of supporting data

All data generated during this study are included in this published article and its supplementary files

Authors' contributions

MS, MC and HM performed most of the experiments; MS and MC analyzed the data, and co-wrote the manuscript; DW, YH and LN formed the data curation and surgery support for this study. HM conceptualized, designed, funding acquisition, directed the project, and wrote the manuscript. All authors edited and approved of the final version of the manuscript.

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Figures

Figure 1

Age and sex distributions of patients with primary intraspinal tumors.

(A) Age and sex distributions in 589 patients with primary intraspinal tumors. (B) Age and sex distributions of patients with primary cervical intraspinal tumors. (C) Age and sex distributions of patients with primary thoracic intraspinal tumors. (D) Age and sex distributions of patients with primary lumbar intraspinal tumors. (E) Age and sex distributions of patients with primary intradural extramedullary intraspinal tumors. (F) Age and sex distributions of patients with primary intramedullary intraspinal tumors. (G) Age and sex distributions of patients with primary **epidural** intraspinal tumors. (H) Age and sex distributions of patients with **schwannomas**. (I) Age and sex distributions of patients with **meningioma**. (J) Age and sex distributions of patients with **teratoma**. (K) Age and sex distributions of patients with **cyst**. (L) Age and sex distributions of patients with **angioma**.

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