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Original Article

Surgical Outcome of Tumors of Spinal cord, Nerve roots, Meninges, and Vertebral column – Our Experience in Tertiary level Hospital

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Abstract:

Background: *Spinal cord tumors can result in dramatic neurological and functional disabilities in the patients. We aimed to know the different types of spinal tumors and the correlation between clinical presentation and pathological findings and compare the outcomes of these tumors postoperatively.*

Methods: *A total of 410 patients were included in the retrospective study group. The duration of the study was January 2016 to October 2022 (82 months). After a thorough clinical evaluation, patients were subjected to magnetic resonance imaging (MRI) and then surgery. They were described based on age, sex, location of the tumor, type of the tumor, symptoms, histopathological type, surgical resection, and complications.*

Results: *The study included 229 (56%) males and 181 (44%) females and their ages ranged from 6 years to 74 years. Out of the 410 patients, 203(49.51%) had intradural extramedullary, 121(29.51%) had extradural and 86(20.98%) had intradural intramedullary spinal tumors. A predilection towards the thoracic region (39.50%) and cervical region (28.40%). Lumbar region (20.10%) and Sacral region (4.10%), Cervico-dorsal region (1.40%), Dorsolumbar region (3.00%), and Craniovertebral junction (3.50%) were seen. The tumors were excised completely in 72.68% of the patients while near-total resection was done in 17.82%, subtotal resection in 7.32%, and only biopsy in 2.2% of patients. Histopathologically most of the tumors were Schwannoma (38.78%), then Meningioma (11.71%), Ependymoma (11.70%), Astrocytoma (10.98%), and others were found. There was significant improvement (33.66%) in the modified McCormicks score at discharge follow-up.*

Conclusions: *Intradural extramedullary is the most common spinal cord tumor. The majority of the cases presented with sensorimotor symptoms and pain is the predominant clinical complaint. Spinal cord tumors are most commonly observed in the 2nd to 4th decade of life with a gradual decline in the incidence towards the extremes of age group. Surgery is the definitive treatment and the aim of the surgery is gross total resection.*

Key Words: I*ntradural, Extradural, Extramedullary, Spinal tumor, functional disabilities.*

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Introduction:

The spinal cord, a caudal tail-like extension of the brain with millions of neurons, ascending and descending tracts, nerve fibrils, vessels, cerebrospinal fluid (CSF) spaces, etc., is hanging by nerve roots, pial bands, and covered within delicate and fibrous meninges, ligaments, vascular network, and a long segmented strong bony cage called the spinal column. The spinal cord extends from the medulla oblongata in the brain stem to the lumbar region of the vertebral column. 15% of primary CNS tumors are intraspinal. There is disagreement over the prevalence, prognosis, and optimal treatment. Most primary CNS spinal tumors are benign. May be classified into 3 groups based on the compartment involved. Although metastases may be found in each area, they are most commonly extradural. Extradural lesions are less common in neurosurgical clinics because many of these tumors are managed by oncologists without requiring neurosurgical involvement. 1. Extradural (ED) (55%): arises outside the cord in vertebral bodies or epidural tissues, 2. Intradural extramedullary (ID-EM) (40%): arises in leptomeninges or roots. Primarily meningiomas and neurofibromas (together = 55% of ID-EM tumors), 3. Intramedullary spinal cord tumors (IMSCT), 5%: arise in Spinal cord substance. Invade and destroy tracts and gray matter.

The malignant and benign tumors of the spinal column, meninges, nerve roots, or the cord parenchyma itself may compress and damage components of the spinal cord to cause neural deficits at all ages. The lack of any specific clinical characteristic often precludes early diagnosis of the lesion and results in most patients being diagnosed with advanced neurological impairments such as paralysis and bladder incontinence. Radiological evaluation with magnetic resonance imaging (MRI) has however led to decreased lag time in the diagnosis of such lesions.

The management of spinal tumors is mainly surgical and the proximity and intimate involvement of neural tracts in the tumor makes surgery difficult and increases surgical morbidity. The aggressive surgical procedures result in deterioration of the neurological status and hence a more conservative excision of the tumor with adjuvant radiotherapy may be an available alternative. Multiple studies have proven that optimum surgical excision of the tumor provides the best outcome. In tumors that have definite planes, there is a consensus toward total excision but controversy still exists between radical tumor excision and near total excisions with adjuvant therapy, particularly in tumors with ill-defined margins/planes.

The role of adjuvant therapy is also variable in different histotypes and depends on the totality of the excision of tumors. The role of chemotherapy is still questionable in spinal tumors. With these points in mind, we studied the clinical presentation, histological diagnosis, management, and functional outcome of patients presenting with spinal tumors.

The objective:

To describe the pattern, location, types, and treatment outcomes in patients diagnosed with different spinal tumors.

Materials and methods:

Study design: A retrospective study

Study place: Department of Neurosurgery- Spine, National Institute of Neurosciences and Hospital, Sher-E-Bangla Nagar, Dhaka

Study duration: January 2016 to October 2022 (82 months).

Study population: The patients admitted with spinal tumors who had undergone operative procedures. Total number of patients were 410. All patients presenting with neurological clinical features were evaluated thoroughly by academic residents of neurosurgery. They were subjected to systematic physical and neurological evaluation, and radio diagnostic studies were performed and any doubtful features were checked by an academic faculty. The standard diagnostic tool was MRI (with or without contrast). The clinical details and demographic data of each case were recorded. Their motor and sensory functions were documented. The motor power grading was done using the Medical Research Council (MRC) grading. The sensory compromises were recorded quantitatively. Sphincter functions were assessed and recorded. The level of the lesion was recorded. The patients were then subjected to surgery after obtaining anesthetic clearance following requisite investigations for anesthetic and other considerations. The surgeries were carried out under an operating microscope. The surgeon decided on his clinical experience and visual confirmation of the extent of dissection and resection required. Postoperatively patients were subjected to adjuvant radiotherapy. The patients were then followed up clinically and radiologically at discharge, 6 weeks,

3, 6, and 12 months and thereafter depending on neurological progression. Only those patients having a follow up of more than 3 months were included in the present series. A neurological examination was carried out at each follow up and recorded in terms of improvement, deterioration, or stabilization. Any evidence of recurrence was duly noted and diligently followed up with further diagnostic.

Inclusion Criteria: Cases who were diagnosed clinically and radiologically with primary and secondary tumors of the spinal cord, of all cases and either gender.

Exclusion Criteria: Cases with recurrent tumors, and those who had follow-up less than 2 months post-operative.

Radiologic evaluation:

1. Plain X-ray of the respective area, 2. CT scan of the respective area, 3. MRI of the respective area with or without contrast.

Result:

Total Number of Cases

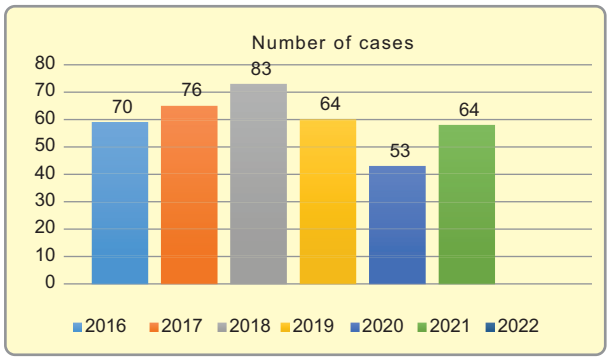


Figure 1: *Total Number of Cases according to years in the diagram*

Table-I

Patient ages at diagnosis

Age groups (years)	Frequency	Percent
0 to10	2	0.48%
11 to 20	35	8.54%
21 to 30	82	20%
31 to 40	112	27.32%
41 to 50	83	20.24%
51 to 60	58	14.15%
61 to 70	28	6.83%
71 to 80	10	2.44%

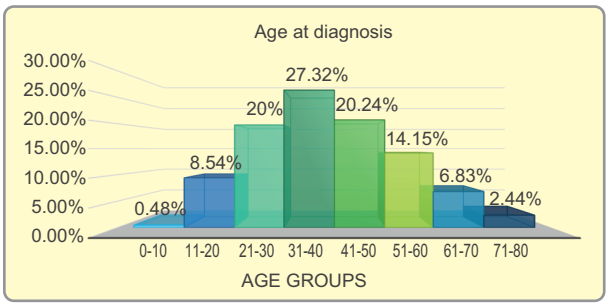


Figure 2: *Percentage of age at diagnosis*

The distribution of age of the study subjects is shown in Table I. The ages of the patients were 6 years to 74 years. The mean age was found to be 38.18±5.43 SD. The peak age incidence was in the third to fourth decade.

Sex distribution:

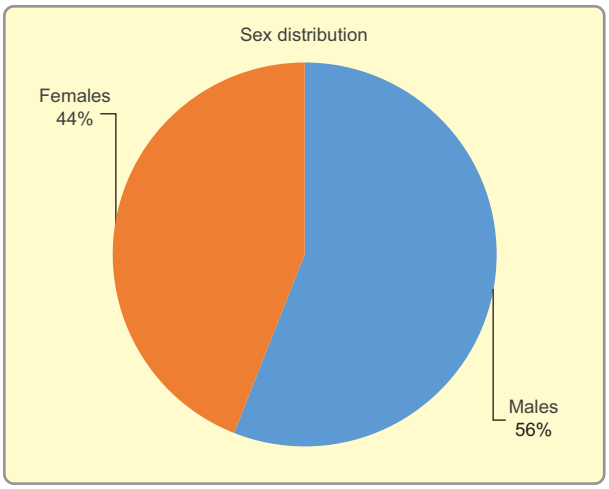


Figure 3: *Distribution of sex among patients*

A total of 410 patients were included with 229(56%) and 181(44%) females. The male-to-female ratio was 1.27:1.

Clinical evaluation:

Presenting Symptoms

Fig-4 shows the preoperative clinical features of the study subjects. Pain-406 (98.78%), Numbness-316 (77.07%), Sphincter involvement (bowel and bladder complaints- 207 (50.48%), Paraparesis-119 (19.02%), Paraplegia-74 (18.05%), Quadriparesis-34 (8.30%), Cauda equina syndrome-13 (3.17%)

Regarding the duration of the chief complaint at diagnosis

50 (12.20%) patients had the symptoms for less than six months, 102(24.87%) for six months to one year, and 258 (62.93%) for more than one year.

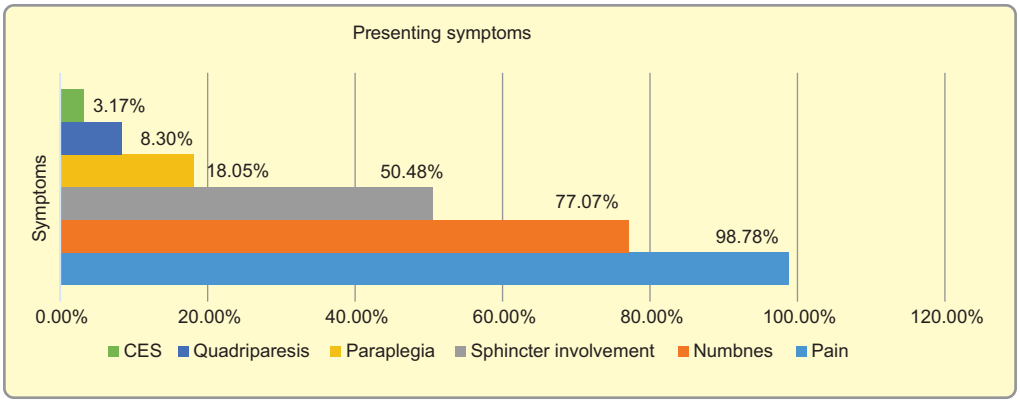


Figure 4: *Clinical Evaluation in percentage in diagram*

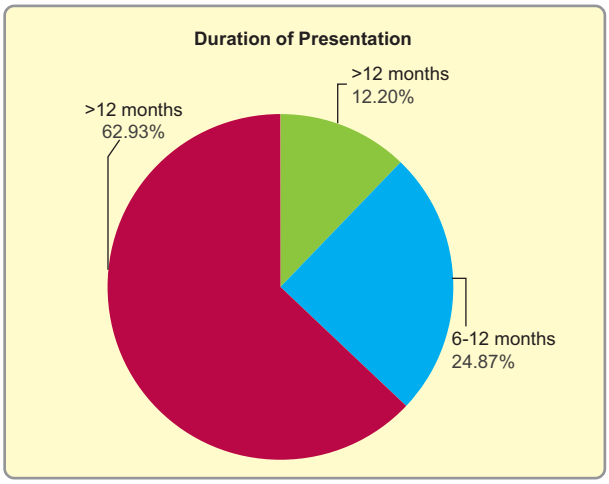
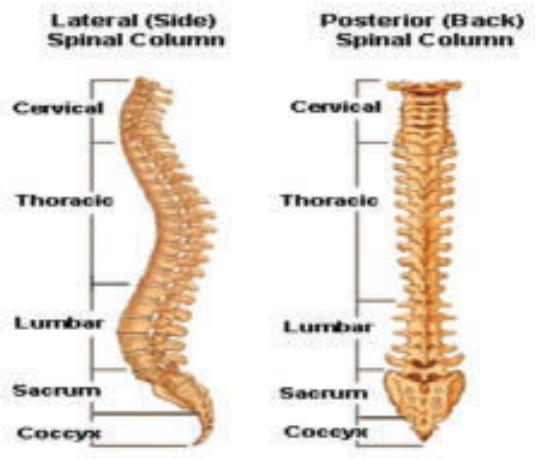


Figure 5: *Duration of Presentation of Complaints*

Distribution of Location of spinal tumor:
Cranio-vertebral junction—3.50%, Cervical—28.40%, Cervicodorsal—1.40%, Dorsal—39.50%, Dorsolubar-3.00%, Lumbar—20.10%, Sacral—-4.10%.



Operative procedure:

Surgical resection

Table-II

Types of surgical Resection

Trait	Number	Percentage
Gross total	298	72.68%
Near total	73	17.82%
Subtotal	30	7.32%
Biopsy only	9	2.2%

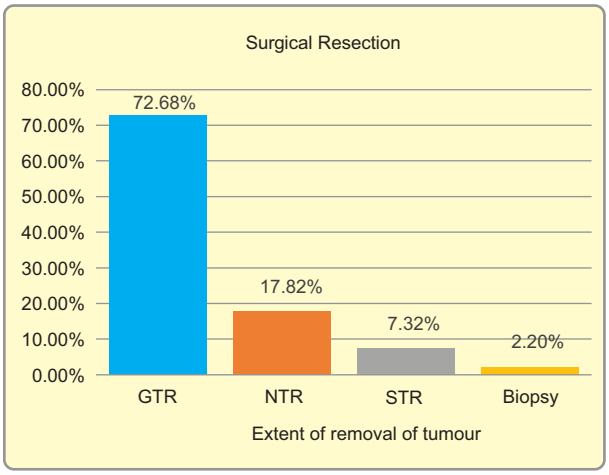


Figure 6: *Types of surgical resection*

Histopathological types of spinal Tumors:

Schwannomas—38.78%, Meningioma—11.71%, Ependymoma—11.70%, Astrocytoma—10.98%, Arachonoid cyst—6.34%, Chordomas—6.10%, TB—2.46%, Metastases—2.44, Lipoma—1.46%, Neurofibroma—0.73%, NonHodgkin's lymphoma—0.73%, Syringomyelia—0.73%, Abscess—0.73%.

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Follow-up after Operation:
Clinical improvement

Table-III
Clinical improvement after operation

Trait	Number	Percentage
Immediate improvement	104	25.36%
Improvement at discharge	138	33.66%
Improvement at first-month follow-up 12 months	70	17.07%
No improvement	72	17.56%
Deterioration	26	6.34%

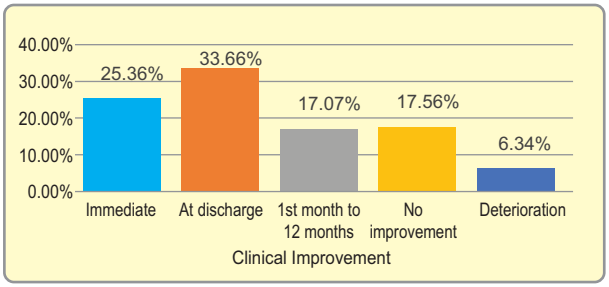

Figure 7: *Follow-up of Clinical improvement after operation*

Classification of Spinal Tumors:
Extradural spinal tumors were 121 (29.51%), Intradural Extramedullary tumors were 203 (49.51%) and Intramedullary tumors were 86 (20.98%)

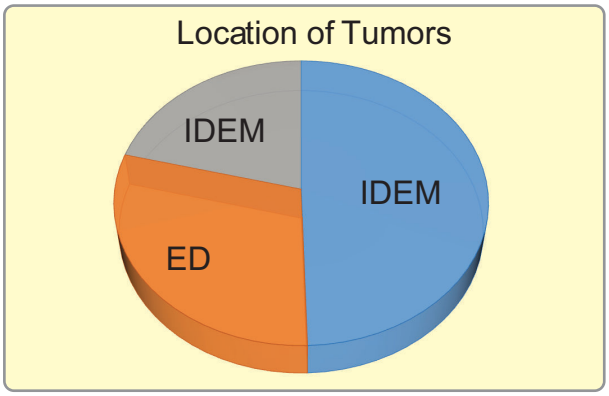

Figure 8: *Classification of spinal Tumors*

Post-operative complications in patients:

Table-IV
Post-operative complications

Trait	Number	Percentage
CSF leakage	6	1.46%
Wound infection	4	0.98%
Pseudo-meningocele	2	0.49%
Pneumonia	2	0.49%

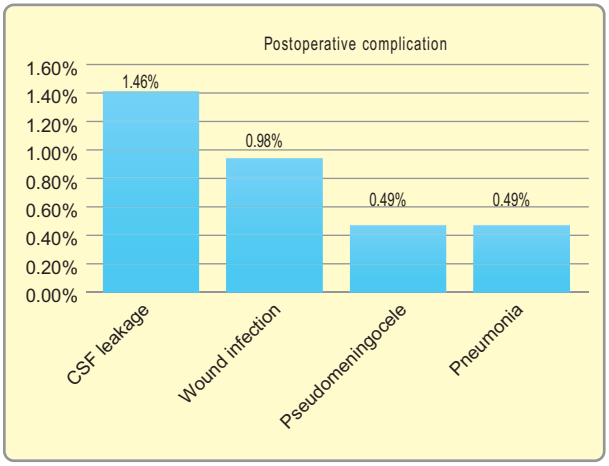

Figure 9: *Postoperative complications*

Table 5: Modified McCormicks grade was used to evaluate the neurological and functional status of patients with spinal tumors:

Grade	Modified McCormick Scale
I	Intact neurologically, 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

Grade	Preoperative	Postoperative
I	147 (35.85%)	185 (45.12%)
II	81 (19.76%)	66 (16.10%)
III	67 (16.34%)	37 (9.02%)
IV	44 (10.73%)	47(11.46%)
V	71 (17.32%)	75 (18.29%)

Discussion:
Incidence

In 2012, Duong *et al*. reported that the incidence of combined malignant and nonmalignant primary spinal tumors differs by age, sex, race, and ethnicity. Their results indicated that malignant primary spinal tumors have been stable throughout the 1999–2007 period.

However, the age adjusted incidence rate for nonmalignant primary spinal tumors was significantly higher than the observed rate for malignant tumors. The incidence rate for malignant and nonmalignant primary spinal tumors combined was lowest in children aged 0–9 years and was highest in adults aged 70–79 years [2, 3]. Schellinger *et al*. found that incidence rates were lowest in children aged 0–19 years and highest in adults aged 75–84 years.[4] Likewise, similar age specific rate patterns were also found in South Korea and Estonia among patients with central nervous system tumors.[5,6] Patil *et al*., noted that 9% of the patients treated were <18 years of age.[7]

We have found that (Table I and Fig:2) maximum patients were in the age group 31 to 40 years (27.32%), then 41 to50 years (20.24%), then 21 to 30 years (20.00%) and 51 to 60 years (14.15%). The mean age of the patients was 38.18±5.43 SD.

Sex

Duong *et al*. found differences in primary spinal tumors by behavior and sex. Approximately 60% were diagnosed in women compared with 40% in men. The male-to-female ratio for ependymomas was 1.15 and lymphomas 1.76 while for tumors of spinal nerves, it was 1.11 and meningiomas 0.28.[2] A study revealed that 53% were women in all spinal cord tumors.[6] The study by Loblaw, *et al*. in 2003, observed 57% of males among a population of malignant spinal cord compression.[8] Schellinger *et al*. found that the overall incidence rate among men was 0.70 per 100,000 persons whereas women had an incidence rate of 0.77 per 100,000 persons.[3]

Our study (Fig 3) shows that a total of 410 patients were included with 229(56%) and 181(44%) females. The male-to-female ratio was 1.27:1.

Location

Nittner reported that 50 % of these tumors are found in the thoracic spine and occur in the cervical and lumbosacral spines at 22 and 18 %, respectively [13]. Tumor types in this region include nerve sheath tumors, e.g., schwannomas in 23–48 %, meningiomas in 9.6–35 %, neurofibromas in 4–23 %, and metastatic tumors in 6.4–25 % [3, 14,15].

We found in this study a predilection towards the thoracic region (39.50%) and cervical region (28.40%). Lumbar region (20.10%) and sacral region (4.10%), Cervico-dorsal region (1.40%), Dorsolumbar region (3.00%), and Craniovertebral junction (3.50%) were seen.

Clinical presentation

Fig-4 shows the preoperative clinical features of the study subjects. Pain-406 (98.78%), Numbness-316 (77.07%), Sphincter involvement (bowel and bladder complaints- 207 (50.48%), Paraparesis-119 (19.02%), Paraplegia-74 (18.05%), Quadriparesis-34 (8.30%), Cauda equina syndrome-13 (3.17%). Fig 5 also shows that 50 (12.20%) patients had the symptom for less than six months, 102(24.87%) for six months to one year, 258 (62.93%) for more than one year.

Surgical Resection

Lee et al. revealed the rate of complete resection was approximately 90% for ependymoma and hemangioblastoma and 50-76% for low-grade astrocytoma [16]. They also stated that complete resection was possible only in 16.6% of malignancy tumors [17]. However, adult patients with malignant intramedullary tumors treated with gross total resection had significantly lower mortality and prognosis than patients treated with subtotal resection, biopsy, or non-surgical measures [18]. The total resection of the malignancy tumor was difficult but may improve survival.

Table 2 and Fig 6 show the Extent of surgical Resection of spinal tumors. We found in this study that Gross total removal of tumors was done in 298(72.68%), near total removal in 73(17.82%), Subtotal removal in 30 (7.32%), and biopsy only in 9(2.2%).

Surgical outcome

Bhat et al. reported an in hospital mortality rate of 0.55% and a complication rate of 17.5% in spinal cord tumors such as ependymoma, astrocytoma, and hemangioblastomas.[19]. They also reported that almost all the patients experienced a significant neurological improvement after surgery, with a percentage of Nurick Grades 1 and 2 of 68% among patients with meningiomas and 66% patients with schwannomas.[12] Patchell *et al*. studied 101 metastatic spinal cord compressions in which 84% (42/50) had postoperative good recovery (able to walk) compared to only 57% (29/51) postradiotherapy good recovery. In the evaluation of long term clinical efficacy at the time of final follow up (12–60 months, average 28 months), improvement was regarded as effectivity whereas no change and deterioration were regarded as nullity [19, 20, 21]

Nittner [21] reported that patients with Grade III and IV muscle power showed significant improvement and

far exceeded the improvement in patients with lower MRC grading. This could be because a good preoperative status collaborates with less infiltration of tumor mass into neural tracts and recent tumor effect which could be reversed with surgery. Furthermore, the fact that even a single grade improvement in muscle power for Grade III resulted in significant functional improvement was instrumental in the improved outcome in these patients. This again emphasizes the role of early diagnosis and timely, aggressive surgical management in IMSCTs. A pertinent point in this regard was that our being tertiary center patients presented to us late which led to a deterioration in their neurological status, thus the importance of an effective referral system. [21].

Our study reveals (Table 3) the Clinical improvement after operation. Immediate improvement after the operation was found in 104 (25.36%), Improvement at discharge was found in 138 (33.66%), Improvement at first-month follow-up 12 months was found in 70(17.07%), No improvement was found in 72 (17.56%) and Deterioration was found in 26(6.34%) (Fig 7).

Table 4 and Fig 9 show the postoperative complications of patients. CSF leakage was found in 6 (1.46%), Wound infection was found in 4 (0.98%), Pseudo-meningocele 2(0.49%), and Pneumonia 2 (0.49%).

Modified McCormicks grade (Table 6) was used to evaluate the neurological and functional status of patients with spinal tumors. Preoperatively grade I, II, III, IV, and V were found 147 (35.85%), 81(19.76%), 67(16.34%), 44(10.73%), and 71(17.32%) respectively. Postoperatively Grades I, II, III, IV, and V were found in 185 (45.12%), 66 (16.10%), 37 (9.02%), 47(11.46%), and 75 (18.29%) respectively. The neurological and functional status of patients with spinal tumors improved some of the patients after operations in this study.

Histopathology

Tihan *et al*. reported that intramedullary spinal cord tumors are rare and account for only 5–10% of spinal tumors.[11] Duong *et al*. reported that among 11,712 primary spinal tumor incident cases, diagnosed from 2004 to 2007, there were 22.0% (2576) malignant cases and 78.0% nonmalignant primary spinal tumors. The most common histologic types of tumors (62%) were myxopapillary ependymomas.[11] The most common spinal tumor was meningiomas (33%) followed by tumors of spinal nerves (27%) and ependymomas (21%). The spinal cord was the origin of 60.5% of all the primary spinal tumors (combined) followed by spinal meninges .36.0% and cauda equina .3.5%. Albanese and Platania, 2002, reported that spinal IDEM tumors account for 2/3 of all intraspinal neoplasms and are mainly represented by meningiomas (25–46%) and schwannomas.[23] Researchers in a study of primary spinal cord tumors reported that the spinal cord was the origin of the tumor in 70.0% of patients, spinal meninges in 26.0%, and cauda equina in 4.0% of patients. While the most common histologic type of spinal tumors were meningiomas (29%), this was followed by nerve sheath tumors (24%) and ependymomas (23%).[24] The Croatian study noted that more than 50% of the spinal tumors diagnosed in the population were located in the spinal meninges.[25] However, these results differed from a Norwegian study that found equal proportions of tumors originating from the spinal cord and spinal meninges.[26]

Bhat et al. revealed that the most common histologic type of, all 14.87% (79/531) IDIM, cord tumors is IM ependymoma (7.15% =38/531 excluding myxo papillary variety) followed by astrocytomas (3.76%=20/531). IDEM tumors occurred in 68.73% (365/531) patients, and the most common tumor type schwannoma was found in 26.74% (142/531) patients followed by the meningiomas 16.57% (88/531) and neurofibromas 12.99% (69/531). The Bhat et al. study showed that total surgical excision of the tumor was carried out in 81.54% (433/531) patients, in which 1.88% (10/531) were ED ID, 10.92% (58/531) IDIM, and 68.73% (365/531) were IDEM.

The present study found that Extradural spinal tumors were 121 (29.51%), Intradural Extramedullary tumors were 203 (49.51%), and Intramedullary tumors were 86 (20.98%) [Fig 8].

Among these, we found that Schwannomas 38.78%, Meningioma 11.71%, Ependymoma 11.70%, Astrocytoma 10.98%, Arachnoid cyst 6.34%, Chordomas 6.10%, TB 2.46%, Metastases 2.44, Lipoma 1.46%, Neurofibroma 0.73%, NonHodgkin's lymphoma 0.73%, Syringomyelia 0.73%, and Abscess 0.73%. The possible explanations for these variations in the present study may be the small sample size and the difference in the population size. The primary malignant vertebral and metastatic deposits were

treated with maximum debulking to achieve standard stability by instrumentation (fixation) and optimal results from postoperative chemoradiation therapy.

In the past, some physicians recommended conservative surgery followed by irradiation for IMSCTs because total removal of the tumor may injure the normal spinal cord around the tumor [34]. However, by improving medical instruments such as high-field MRI, surgical tools including microscope with high-definition technology, ultrasonic aspirator, and intraoperative monitoring, surgery of IMSCT has become much safer [26]. Recently, a microsurgical resection has been considered the gold standard in the treatment of IMSCT with the aim of complete tumor removal [3]. Radiotherapy and chemotherapy should only be preserved for high-grade lesions or some cases of low-grade tumors with incomplete resection and clinical worsening [28]. Recently, stereotactic radiosurgery for intramedullary spinal lesions has been reported [26]. Stereotactic radiosurgery was done for metastasis, vascular malformation, and benign tumors. Although a very limited number of cases were done, they suggested that stereotactic radiosurgery is an effective and safe alternative option to conventional radiotherapy.

Recently, advanced microsurgical skills and intraoperative neurophysiological monitoring have made more aggressive chances for total and nearly total resection of IMSCT [26, 27, 28]. In this study, the extent of tumor resection was not associated with postoperative neurological outcomes. However, several authors reported a series with complete tumor removal and good postoperative

Functional outcome [29,30,31]. We didn't find statistical results between the extent of tumor resection and neurological outcome, and we thought that total resection should be tried in low-grade tumors. Only in high-grade tumors and tumors where total removal had not been possible, we suggest partial resection or biopsy with radiotherapies and chemotherapies.

The possibility of postoperative poor prognosis increased when the neurological defect happened. Additionally, the thoracic spinal cord had been reported to be more liable to radiation damage [32, 33], which may be a cause of neurologic defects in survivors with malignancy tumors. On the other hand, thoracic IMSCT was associated with increased survival when compared to other locations [34, 35]. Tumors located in the thoracic spinal cord take a longer time to invade the respiratory center leading to respiratory failure (a common cause of death among patients with intramedullary malignancy tumors than tumors initially growing from the cervical spinal cord) [35].

Neurosurgical advances such as improving neuroimaging, intraoperative neurophysiological monitoring, microsurgical technique, and operative instruments made it possible to achieve total resection of IMSCTs. So neurosurgeons should have a challenging attitude toward the total removal of low-grade tumors.

Conclusions:

Intradural extramedullary is the most common spinal cord tumor. The majority of the cases presented with sensorimotor symptoms and pain is the predominant clinical complaint. Spinal cord tumors are most commonly observed in the 2nd to 4th decade of life with a gradual decline in the incidence towards the extremes of age group. Surgery is the definitive treatment and the aim of the surgery is gross total resection. Complete excision is not possible in most of the intramedullary cases. The treatment of choice for the malignant and metastatic tumor group of the spinal cord and column was the maximum resection with adjuvant chemoradiation therapy.

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