Original Article

Analysis of Intramedullary Tumors; Experience at Tertiary Care Hospital

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ABSTRACT

Objective: This 6-year comprehensive study investigated the incidence, etiology, pathological characteristics, and diagnostic modalities of IMSCTs in an effort to advance our comprehension of these tumors.

Study Design: Cross-sectional observational study.

Place and Duration of Study: This study was conducted at the Department of Neurosurgery of Mardan Medical Complex, Mardan from January 2017 and February 2023.

Materials and Methods: In which demographic information, clinical presentations, medical histories, and radiological findings of 48 patients diagnosed with IMSCTs were analyzed.

Results: The findings demonstrated that IMSCT patients have a diverse age distribution. The preponderance of patients (56.25%) was older than 40 years of age, indicating a higher prevalence among older individuals. The vast majority of patients suffered from pain (81%), motor impairments (78%), sensory disturbances (85%), neurological deficits (80%), and paresthesia (63%). In evaluating and diagnosing IMSCTs, advanced imaging techniques, particularly magnetic resonance imaging (MRI), performed a crucial role. Location, size, and structure of the tumor were revealed by MRI scans, among other tumor characteristics. The prevalence of IMSCTs was highest in thoracic region (60.41%), followed by lumbar region (25.0%), cervical region (10.41%), and lumbosacral region (4.16%). Histopathological analysis revealed that ependymoma (41.7%) and astrocytoma (31.3%) are the most common subtypes of tumor.

Conclusion: This exhaustive study provided valuable insights into the incidence, clinical manifestations, imaging characteristics, and treatment considerations associated with IMSCTs.

Key Words: Diagnostic modalities; MRI; Spinal cord tumors; Tumor location; Tumor subtypes.

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INTRODUCTION

Intramedullary spinal cord tumors (IMSCTs) present a unique and formidable challenge to neurology [1-2]. These neoplasms account for approximately 5-10% of all central nervous system tumors; they differ from extradural and intradural tumors, which affect the spinal cord from outside or inside the dura mater, respectively[3].

Due to their intricate location and possibility of significant neurological complications, IMSCTs present challenging clinical scenarios. Individuals of all ages can be affected by these tumors, and while the exact etiology is largely unknown, some IMSCTs are considered primary, originating spontaneously within the spinal cord, while others may be secondary, resulting from metastasis or extension from contiguous structures[4].

Clinical manifestations of IMSCTs can vary considerably based on variables such as tumor location, size, and growth rate. Patients frequently experience pain, sensory disturbances, motor impairment, and progressively worsening neurological deficits[5]. The precise anatomical localization of IMSCTs within the spinal cord is crucial for determining the specific clinical manifestations and appropriate treatment strategy. The diagnosis of IMSCTs requires a multidisciplinary approach that includes clinical evaluation, neuroimaging modalities, and histopathology[6-7]. The gold standard for evaluating these tumors is magnetic resonance imaging (MRI), which provides comprehensive information about their location, extent, and relationship to adjacent structures[8-9].

Understanding and administration of IMSCTs have advanced significantly over the past few years. These include the development of refined surgical techniques, intraoperative monitoring techniques, advanced imaging modalities, and targeted therapies. The overarching objective of ongoing research endeavors is to improve patient outcomes by further refining

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diagnostic strategies, optimizing treatment approaches, and exploring innovative therapeutic options.

This study presented the findings of a 6-year comprehensive study that examined the progress made in comprehension of IMSCTs and investigated various aspects of IMSCTs, including their incidence, etiology, pathological characteristics and diagnostic modalities. The study provided valuable insights into the nature of IMSCTs and their influence on patient prognosis and emphasized the significant developments that have occurred over the past six years.

MATERIALS AND METHODS

This cross-sectional investigation of IMSCTs was carried out in the department of Neurosurgery, Mardan Medical Complex, Mardan. Prior to data acquisition, approval from the institutional review board was obtained. Between January 2017 and February 2023, a total of 48 patients diagnosed with IMSCTs at the Hospital were included in this study. Patients diagnosed with IMSCTs at the hospital, regardless of age or gender, met the inclusion criteria. Radiological imaging, such as MRI, and histopathological analysis were required for diagnosis confirmation. While, patients whose medical records were fragmentary or lacked crucial diagnostic information and who were unwilling were excluded.

Patient data, including demographic information, clinical presentations, and pertinent medical history, were extracted from electronic medical records. A review of radiological imaging reports, specifically MRI images, was conducted to extract information on tumor location, size, and other relevant characteristics. Examining histopathological reports to determine tumor type, grade, and other histological characteristics.

Categorical variables were reported as frequencies and percentages. To investigate potential correlations between tumor characteristics and clinical variables, subgroup analyses were conducted at SPSS 25.0 employing ANOVA tests.

Institutional review board approval was obtained to ensure patient confidentiality and privacy throughout the study. Identifiers of patients were anonymized, and data were handled in accordance with ethical standards.

This study has some limitations to consider. The sample size of 48 patients may limit the generalizability of the results. In addition, as a single-center study, it is possible that the results are not representative of the general population.

RESULTS

Between January 2017 and February 2023, 48 patients were diagnosed with IMSCTs. In this study, age distribution of patients with IMSCTs indicated that the condition affected a broad range of ages. The maximum proportion of patients (56.25%) were over the age of 40, indicating that IMSCTs are more common in older individuals. The second-largest group (29.16%) consisted of patients between the ages of 19 and 40, indicating that IMSCTs can also affect younger adults. The smallest cohort consisted of patients younger than 18 (14.58%), indicating that IMSCTs are less prevalent in pediatric populations. The substantial p-value ($p<0.05$) indicated a strong correlation between age and occurrence of IMSCTs, emphasizing the significance of age as a risk factor for the development of these tumors (Table 1).

The data depicted the diverse clinical manifestations observed in patients with IMSCTs. The vast majority of patients suffered from pain (81%), motor impairments (78%), sensory disturbances (85%), neurological deficits (80%), and paresthesia (63%). These results demonstrated the vast array of symptoms that can be caused by IMSCTs and emphasized the complex effect these tumors have on the spinal cord and surrounding neural structures. Pain, sensory disturbances, and motor impairments were especially prevalent, indicating that the tumor caused considerable functional disruptions. The large percentages indicated that these symptoms were prevalent and should have been thoroughly assessed in patients with suspected or confirmed IMSCTs. Understanding the clinical manifestations of IMSCTs was essential for prompt diagnosis, appropriate treatment planning, and the management of patient symptoms and overall health (Figure 1). The radiological characteristics of IMSCTs observed via MRI scans from C2-C6 were manifested including information regarding the location, size, and structure of the tumors as depicted on the MRI images (Figure 2). MRI is the imaging modality of choice for evaluating IMSCTs because it provides comprehensive information regarding the location, extent, and relationship to adjacent structures of the lesions.

The majority of malignancies were found in thoracic region (60.41%), followed by lumbar region (25.0%), cervical region (10.41%), and lumbosacral region (4.16%). This data revealed the anatomical distribution of IMSCTs in the spinal cord. In terms of tumor subtypes, ependymoma was the most prevalent, accounting for 41.7% of cases. Astrocytoma was the second most prevalent form of tumor, affecting 31.3% of patients. Hemangioblastoma comprised 12.5% of tumors, while the remaining 14.6% were comprised of other forms of tumors. These results cast light on the histopathological diversity of IMSCTs and highlighted the significance of accurate tumor classification for proper treatment. 33.3% of the tumors in the analyzed cases were classified as Grade I, 25.0% as Grade II, 20.8% as Grade III, and 20.8% as Grade IV. The grade of a tumor is crucial in determining its aggressiveness and prognosis. The significant p-values for tumor location, type and grades ($p<0.05$) indicated substantial associations between these characteristics and incidence of IMSCTs (Table 2).

Table No. 1: Demographic Characteristics of Patients WITH IMSCTs

S. No	Variable	Frequency (n=48)	Percentage (%)	p-value
1	Age (years)			
	<18	07	14.58	
	19-40	14	29.16	**0.00001***
	>40	27	56.25	
2	Gender			
	Male	29	60.41	**0.00015***
	Female	19	39.58	
3	Time from onset of symptoms (months)			
	<1	14	29.16	
	1-3	26	54.16	**0.00001***
	>3	08	16.66	

***indicated that the value is significant (p<0.05)**

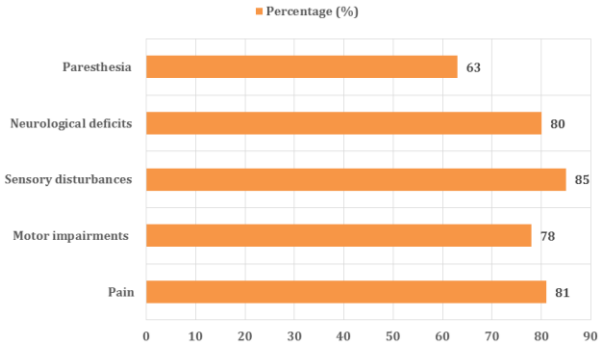

Figure No. 1: Clinical presentation of the patients with IMSCTs

MRI for Intramedullary Spinal Cord Tumor C2 to C6

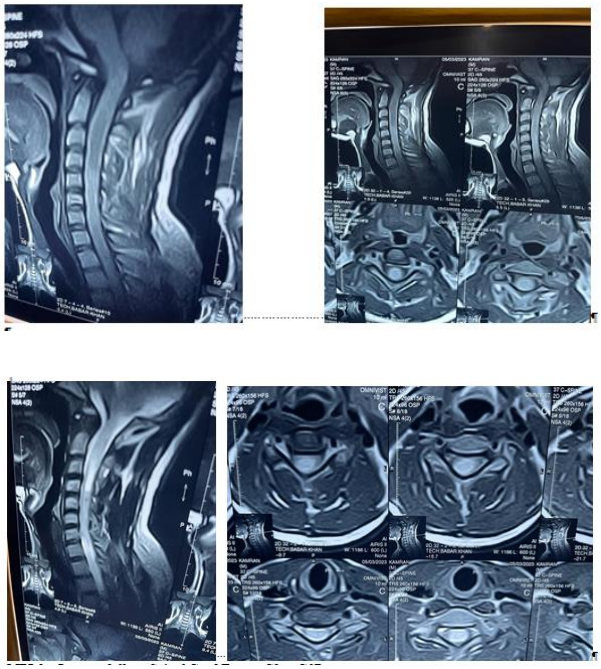

Figure No. 2: MRI-based radiological characteristics of IMSCTs

Table No.2: Radiological and Histopathological Characteristics of IMSCTs

Tumor Characteristic	Frequency (n=48)	(%)	p-value
Tumor location			
Cervical	05	10.41	0.00001*
Thoracic	29	60.41	
Lumbar	12	25.0	
Lumbosacral	02	4.16	
Tumor Type			
Ependymoma	20	41.7	0.00001*
Astrocytoma	15	31.3	
Hemangioblastoma	06	12.5	
Others	07	14.6	
Tumor Grade			
- Grade I	16	33.3	0.00469*
- Grade II	12	25.0	
- Grade III	10	20.8	
- Grade IV	10	20.8	

***indicated that the value is significant (p<0.05)**

Table No. 3: Tumor Enhancement Pattern in IMSCTs

Tumor Enhancement Pattern	Frequency (n=48)	(%)	p-value
Homogeneous	22	45.83	0.00001 *
Heterogeneous	13	27.08	
Rim-enhancing	08	16.66	
Non-enhancing	05	10.41	

***indicated that the value is significant (p<0.05).**

Tumor enhancement patterns were also observed in IMSCTs. In 45.83% of examined IMSCTs, the enhancement pattern was homogeneous, implying uniform enhancement throughout the tumor. In 27.08% of the tumors, heterogeneous enhancement, characterized by irregular or variable enhancement, was observed. In 16.66% of cases, rim-enhancing enhancement was observed, in which the outer rim of the tumor enhanced more conspicuously than the central portion. In 10.41% of the tumors, non-

enhancement, indicating a paucity of contrast uptake, was observed. By comprehending the various tumor enhancement patterns, radiologists and clinicians can distinguish IMSCTs from other spinal cord pathologies and make more accurate diagnoses (Table 3).

DISCUSSION

The comprehensive 6-year study revealed significant insights into the progress made in the comprehension of IMSCTs, posing distinct challenges due to their intricate location and potential neurological complications. This research sought to investigate the incidence, etiology, pathological characteristics, and diagnostic modalities of IMSCTs. The findings revealed significant advancements in the discipline over the previous six years.

The results indicated that IMSCTs can affect a wide spectrum of ages, with the majority of cases occurring in older people. This result is consistent with previous studies that identified age as a risk factor for the development of these malignancies. In a cohort, average age was 59.8 years, and the average follow-up period was 10.6 years (range: 2-16 years). The average time between the onset of symptoms and treatment was 19.4 months. 67% of patients showed no change in clinical function based on the McCormick Scale score at the last follow-up, 9% showed a decline, and 24% demonstrated an improvement after surgery. Thoracic ependymomas were the most frequently observed IMSCTs in patients older than 50, manifesting primarily as sensory symptoms[10]. A comparable study assessed the demographics, incidence, symptoms, histopathology, postoperative complications, and rehabilitation of 122 patients who underwent surgery for spinal tumors during the five years period (2014-19). 19 patients had extradural tumors, 73 patients had intradural extramedullary tumors, and 30 patients had IMSCT. The average age of surgical patients reported was 40.79 years. These results were consistent with our study in most of the aspects [11].

Additionally, the study cast light on the various clinical manifestations of IMSCTs. The patients exhibited a variety of symptoms, including pain, motor impairments, sensory disturbances, neurological deficits, and paresthesia. These symptoms highlighted the complex effects of IMSCTs on the spinal cord and adjacent neural structures. Notably, pain, sensory disturbances, and motor impairments were prevalent, highlighting the significant functional disruptions these tumors caused. The majority of patients exhibited symptoms for six to twelve months [11]. Another investigation concluded that awareness and comprehension of IMSCT are essential for early diagnosis and management planning [2].

The MRI-observed radiological characteristics of IMSCTs provided vital information regarding the location, size, and structure of the tumors. These advances in imaging modalities have contributed to enhanced diagnostic precision and more informed treatment decisions for IMSCTs. Our findings were significantly supported by a study carried out in Bangladesh in 2015-16 indicating that patients with IMSCTs underwent MRI, and 19 patients were diagnosed with ependymomas, 8 were astrocytomas, and one was a hemangioblastoma. The study demonstrated that MRI is a sensitive and effective noninvasive imaging technique for diagnosing IMSCTs [12]. Seventy cases IMSCTs in adults, included ependymoma (39), astrocytoma (11), carcinoma metastasis (8), hemangioblastoma (5), cavernoma (3), and others (4), were evaluated in a study. The distribution of tumor sites was as follows: thoracic (36%), cervical (33%), cervicothoracic (19%), and conus (13%) [13].

IMSCTs' anatomical distribution and histopathological diversity were also investigated. The thoracic region contained the most malignancies, followed by the lumbar, cervical, and lumbosacral regions. This data revealed the anatomical localization of IMSCTs within the spinal cord. The most prevalent tumor subtype was ependymoma, followed by astrocytoma and hemangioblastoma. The correct classification of tumor subtypes is essential for determining the most effective treatment methods. The study also revealed a distribution of tumor grades, with Grade I tumors being the most prevalent. The grade of a tumor plays a crucial role in determining its aggressiveness and prognosis. The most prevalent intramedullary tumor observed was ependymoma, followed by astrocytoma, dermoid cyst, and hemangioblastoma. The extent of tumor resection varied depending on the lesion's histological type and location. For the majority of patients, early diagnosis and surgical intervention were determined to be the most effective treatment method. MRI examination has become the preferred technique for preoperative diagnosis of intramedullary spinal cord tumors, allowing the majority of patients to receive an initial diagnosis [14-16].

The tumor enhancement patterns observed in IMSCTs helped distinguish them from other spinal cord pathologies. Imaging analysis can assist radiologists and clinicians in making accurate diagnoses by identifying patterns of homogeneous enhancement, heterogeneous enhancement, rim-enhancing enhancement, and non-enhancement. This information is useful for treatment planning and therapy response monitoring. The treatment of spinal malignancies has always posed a challenge for surgeons. Historically, conservative surgical excision combined with radiotherapy was advocated as a viable alternative to radical surgery and the resulting neurological morbidity[17-18]. Another study recommended that patients with high-grade astrocytomas should be the only ones to undergo partial resection with radiation therapy[19].

CONCLUSION

This study on IMSCTs has substantially advanced our scientific and technical knowledge of these complex tumors. Notable are the study's findings regarding

incidence, etiology, pathological characteristics, and diagnostic methods of IMSCTs. Age emerged as a significant risk factor for IMSCTs, highlighting the significance of early intervention regardless of preoperative neurological grade. The study highlighted the diverse clinical manifestations and functional disruptions caused by IMSCTs, emphasizing the need for prompt diagnosis and the utilization of advanced imaging techniques such as MRI for accurate treatment planning. The study firmly recommends minimal delay in surgical intervention, with complete tumor removal as the primary objective. Despite the difficulties presented by the spinal cord's fragility, it is essential to preserve neurological function while maximizing tumor resection.

Author's Contribution:

Concept & Design of Study:	Naeem ul Haq
Drafting:	Warda Naeem Khan, Syed Nasir Shah
Data Analysis:	Musawer Khan
Revisiting Critically:	Naeem ul Haq, Warda Naeem Khan
Final Approval of version:	Naeem ul Haq

Conflict of Interest: The study has no conflict of interest to declare by any author.

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