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Characteristics and surgical management of spinal meningiomas in the Himalayan region. A decade-long study at a tertiary care hospital

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Keywords
spinal meningiomas, intradural tumours, surgical management, radiological diagnosis, postoperative complications

ABSTRACT

Background: Spinal meningiomas, originating from arachnoid cap cells, primarily manifest in the intradural extramedullary region, commonly favouring the thoracic area, albeit occurrences in the cervical, lumbar, and exceptionally rare sacral regions have been noted. Among tumours in this location, meningiomas, neurofibromas, and schwannomas prevail. MRI serves as the preferred imaging modality due to its ability to often reveal the distinctive dural origin of meningiomas. Microdissection and resection stand as the established gold standard for treating spinal meningiomas.

Materials and methods: This study, conducted at the Sheri-Kashmir Institute of Medical Sciences Soura Srinagar in Jammu and Kashmir, India, spanned approximately 10 years from August 2009 to July 2017 retrospectively and August 2017 to July 2019 prospectively. It encompassed patients diagnosed with spinal meningiomas, evaluated through comprehensive history-taking, clinical examinations, biochemical assessments, and radiological studies. Surgical interventions predominantly involved laminectomy, aiming for gross total or subtotal tumour resection using a posterior approach. Postoperative complications, such as CSF leaks and wound infections, were monitored, and the duration of hospitalization was recorded from the surgery date to discharge.

Results: The results showed a mean patient age of 44 years, with the youngest being 16 years old and the eldest 70 years old. Most patients (40.90%) fell within the 41-50 age group, with 22.72% in the 51-60 age bracket. Among the 22 patients, females comprised 68.18%, resulting in a female-to-male ratio of 2.1:1. The most prevalent symptoms were pain (77%) and weakness (63%), followed by bladder dysfunction (27%). Tumors were primarily located in the thoracic region (68%), with other occurrences in the cervicothoracic (18%), thoracolumbar (9%), and cervical (4.54%) areas. Posterior surgical approaches were utilized in 91% of cases, with the remaining 9% employing an anterior approach. Tumour sizes varied, with 22.72% smaller than 2 cm and 77.27% larger, having a mean greatest diameter of 2.9 cm. Postoperative

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complications were observed in 9.09% of patients, with CSF leaks and wound infections being the major concerns, while 91% experienced no complications.

Conclusions: In conclusion, this study illustrates spinal meningiomas as slow-growing tumors with a subtle onset, typically appearing in the 4th to 5th decade, and exhibiting a female predominance with a 2:1 ratio. Pain emerges as the most prevalent presenting symptom. Surgery stands as the primary treatment, albeit accompanied by potential postoperative complications such as wound infections, CSF leaks, or bowel and bladder dysfunctions. Adjuvant radiotherapy might be considered for recurrent or advanced disease to offer palliative relief.

Introduction

Spinal meningiomas are tumors that originate from arachnoid cap cells and are commonly situat-ed in the intradural extramedullary region [1, 2]. They predominantly occur in the thoracic region but can also be found in the cervical, lumbar, and rarely, the sacral area [3-5]. The challenges posed by these tumors during surgery vary based on their location along the spinal cord, as well as their orientation—whether anterior or posterior—to the spinal cord and cauda equina. In adults, intradural extramedullary spinal cord tumors constitute approximately two-thirds of all spinal cord tumors, with meningiomas, neurofibromas, and schwannomas being the most common types in this location [7, 8].

Most of the spinal cord meningiomas are situated in the thoracic region, particularly in females, as they occur about 2.5 times more frequently in women than in men, with approximately 75-85% arising in females. Overall, spinal meningiomas represent around 7.5-12.7% of all meningiomas, occurring less frequently than their intracranial counterparts. Most of these tumors are located laterally and typically emerge from arachnoid cap cells within the dural root sleeve [6]. MRI serves as the imaging modality of choice due to its ability to often delineate the characteristic dural origin of meningiomas. These tumors typically appear isointense or hy-pointense to gray matter on T1 and isointense or hyperintense on T2. Radiographically, intraspinal meningiomas display avid homogeneous enhancement with contrast. Additionally, enhancement of the adjacent dura, known as the dural tail, is a characteristic feature of meningiomas [10]. Clin-ically, intraspinal meningiomas may present with varying symptoms depending on their location along the spinal axis. Meningiomas located in the craniovertebral junction and high cervical re-gion often present with myelopathic features and suboccipital pain. They may also cause atrophy of intrinsic hand muscles. Generally, spinal tumors may lead to a dull ache and radicular symp-toms if a nerve root is involved. Bowel and bladder involvement may manifest as a late symptom [13]. Microdissection and resection remain the gold standard for treating spinal meningiomas [9, 14-17].

Cervical meningiomas can pose surgical challenges, especially when they are situated an-terior to the spinal cord, unlike thoracic meningiomas, which tend to favor more posterior and lat-eral locations [18]. Occasionally, a spinal meningioma may present as a dumbbell tumor resem-bling a nerve sheath tumor. Resection of this type of tumor might involve sacrificing the affected nerve root with minimal neurological consequences [6, 19]. The exceedingly rare intramedullary meningioma has been treated using surgical cordectomy as the operative technique [20]. Although uncommon, meningiomas have been described in the lumbosacral spine [21-25]. Multiple spinal meningiomas are relatively rare, especially without an association with NF2 [26, 27]. Treatment options for multiple spinal meningiomas must consider their locations, symptoms, and the pa-tient's premorbid condition.

Symptomatic meningiomas causing significant myelopathic or radiculopathic features should be treated rather than managed conservatively. Post-surgical com-plications such as CSF leak, wound infection, and bladder/bowel dysfunction may occur [4, 9, 12]. Surgery remains the primary treatment for symptomatic multiple spinal meningiomas, though ra-diation therapy may be considered as well [28]. Adjunctive radiation therapy is primarily consid-ered in cases of subtotal resection of recurrent meningiomas or when the risk of surgery is high due to patient comorbidities or tumor location.

The Department of Neurosurgery at Sheri-Kashmir Institute of Medical Sciences (SKIMS) has been managing spinal cord and spinal column tumors since 1982. It is a well-equipped and state-of-the-art center for spinal cord tumor management.

Materials and methods

This study was conducted in our hospital. It encompassed both prospective and retrospective anal-yses, spanning approximately 10 years from

August 2009 to July 2017 retrospectively, and August 2017 to July 2019 prospectively. The study involved patients diagnosed with spinal meningioma. Patients underwent comprehensive evaluations encompassing history-taking, clinical examina-tions, biochemical assessments, and radiological studies.

The patient history collection comprised details such as age, gender, presenting symptoms (pain, numbness, swelling, bowel and urinary dysfunction, leg weakness), symptom duration, any associated comorbidities or prior malignan-cies, and past surgical history. Clinical examinations were conducted, including general physical examinations, systemic assessments (chest, cardiovascular system, abdomen), and detailed neuro-logical examinations, in addition to local assessments. Biochemical and hematological investiga-tions followed these examinations. Subsequently, radiological assessments were performed, in-volving plain X-rays of the spine and CT scans that revealed features such as calcification in cer-tain patients.

MRI scans were then conducted, demonstrating characteristic features indicative of spinal meningiomas. Surgical interventions primarily consisted of laminectomy coupled with total or subtotal tumor resection via a posterior approach. Postoperative complications, including CSF leaks and wound infections, were monitored. The duration of hospitalization was calculated from the surgery date to the discharge date. Patients were regularly followed up as outpatients to moni-tor for recurrence or metastasis. For patients exhibiting recurrence, reoperation or radiation thera-py was employed based on the disease status (locally recurrent or metastatic). The Department of Neurosurgery at SKIMS has been actively involved in surgically managing all types of spinal tu-mors, receiving collaborative support from other affiliated departments.

Results

The mean age of the patients was 44 years, with the youngest patient being 16 years old and the eldest 70 years old. The largest proportion of patients (40.90%) fell within the 41-50 age group, followed by 22.72% in the 51-60 age bracket (Table 1). Among the 22 patients, 15 (68.18%) were females and 7 (31.81%) were males, resulting in a female-to-male ratio of 2.1:1 (Table 2). The most prevalent symptom reported was pain, observed in 17 patients (77%), followed by weakness in 14 patients (63%), and bladder dysfunction in 6 patients (27%) (Table 3). Normal muscle pow-er (grade V) was present in 9 patients (41%), while decreased power (grade III/IV) was noted in 13 patients (59%) (Table 4). Regarding tumor location, 15 patients (68%) had thoracic tumors, 4 (18%) had cervicothoracic tumors, 2 (9%) had thoracolumbar tumors, and 1 (4.54%) had a cervi-cal tumor (Table 5). The posterior approach was employed in the surgical management of 91% of patients, whereas an anterior approach was used in only 2 patients (Table 6). In terms of tumor size, 22.72% of patients had tumors smaller than 2 cm, while 77.27% had tumors larger than 2 cm. The tumor sizes ranged from 1 to 4 cm, with a mean greatest diameter of 2.9 cm (Table 7).

Table 1. Age distribution of study population

Age(years)	N	%
0-9	0	0
10-18	2	9.09
19-30	1	4.54
31-40	3	13.63
41-50	9	40.90
51-60	5	22.72
61-70	1	4.54
71-80	1	4.54
Total	22	100
Mean	44 Years.	
Range	16-70 Years.	

Table 2. Gender Distribution

Gender	N	%
Male	7	31.81
Female	15	68.18

Table 3. Clinical Features

Symptoms	N	%
Pain	17	77.27

Weakness of legs	14	63.63
Swelling	3	13.63
Bowel dysfunction	6	27.27
Bladder symptoms	4	18.18
Mean duration of symptoms	20 months	

Table 4. Neurological Muscle Power (Grade)

Neurological grade	N	%
Grade III/IV	13	59
Grade V	9	41

Table 5. Location of tumors

Site/ Location	N	%
Cervical	01	4.54
Cervicothoracic	04	18.18
Thoracic	15	68.18
Thoraco-lumbar	02	09

Table 6. Surgical approach to tumor

Type of Approach	**N**	**%**
Anterior	2	9
Posterior	20	91

Table 7. Size of tumour (cm)

Tumor size	**N**	**%**
Number of Patients having size of Tumor < 2 cm	5	22.72
Number of Patients having size > 2 cm	17	77.27
Range of tumor size	1-4 cm	
Mean greatest diameter	2.9 cm	

Table 8. Postoperative complications

Complications	**Number of Patients (N)**	**%**
CSF leak	01	4.54
Wound infection	01	4.54
Total patients having complication	02	9
Total patients without complication	20	91

Table 9. Duration of hospital stay

Duration of hospital stay	**No. of patients**	**Percentage**
0-5 days	3	13.63
5-10 days	8	36.36
10-15 days	5	22.72
15-20 days	4	18.18
20-25 days	1	4.54
25-30 days	0	0
30-35 days	0	0
35-40 days	1	4.54
	Total=22	100

Table 10. Local recurrence

	N	**%**
Recurrence	02	9
No Recurrence	20	91

Table 11. Adjuvant therapy

Adjuvant therapy	**N**	**%**
Given	1	5
Not Given	21	95

Post-operatively, 2 out of 22 patients experienced complications, resulting in an overall complication rate of 9.09%. These complications included CSF leak in 4.54% of patients and wound infection in 4.54%. The majority, 91% of patients, did not experience any postoperative complications (Table 8). Regarding hospital stays, 13.63% of patients stayed for 0-5 days, 36.36% stayed for 5-10 days, 22.72% stayed for 10-15 days, 18.18% stayed for 15-20 days, 4.54% stayed for 20-25 days, and 4.54% stayed for 35-40 days.

The range of hospitalization duration varied from 5 to 40 days, with a mean duration of 11 days, as depicted in Table 9. Local recurrence of the disease was observed in 2 patients (9%) among the 22 after a period of 5 years post-surgery within a 7-year follow-up period (Table 10). Adjuvant radiotherapy was administered to 1 patient (4.54%) out of the 22 as part of the treatment regimen (Table 11).

Discussion

Age of presentation

Spinal meningiomas are slow-growing tumors. Most cases are observed in the 4th to 5th decade of life. In our study, the mean age of presentation was 44 years. The youngest patient was 16 years old, while the eldest was 70 years old. Most patients fell within the 40-50 age group. Levy WJ et al. [4], in their study published in 1982, described a mean age of 53 years. Iacob et al. [5], in a study published in 2014, found a mean age of 54 years.

Gender prevalence

In our study of spinal meningiomas, out of 22 patients, 7 were males and 15 were females, result-ing in a female-to-male ratio of 2:1. Several investigators have reported a higher prevalence of women in their series [3, 4, 29, 30, 31]. Gezen F et al. [9] found a female-to-male ratio of 3:1 in their study. Namer IJ et al., in their 1987 study, observed 29 patients with 22 females and 7 males, indicating an approximate F:M ratio of 3:1 [29]. Roux FX et al. reported 54 patients, including 43 females and 11 males, with an F:M ratio of 3.9:1. It has been suggested that spinal meningiomas occur more frequently in fertile women due to a possible dependency of these tumors on sex ster-oid hormones [5, 31].

Symptoms

In our study, pain or low back ache was the predominant symptom, present in 17 cases (77.27%). This aligns with other studies that also describe pain or low back ache as the most common symp-tom [3-5, 9, 29, 32]. Other symptoms identified included weakness and/or numbness in the legs (63.63%), swelling (13.63%), bowel dysfunction (27.27%), and bladder symptoms (18.18%). Namer IJ et al., in their 1987 study, reported that pain was the presenting symptom in all patients [29]. Calogero JA, in a study published in 1972, similarly described pain as the most frequent pre-senting symptom [33].

Duration of symptoms

In Spinal meningioma, the mean duration of symptoms from onset to presentation is typically long. In our study, the mean duration between symptom onset and presentation was 20 months. Levy WJ et al. described a mean duration of symptoms of 23 months in their study [4]. Riad et al. reported a clinical symptom formation range between 12 to 24 months, with an average complaint period of 13.7 months [34].

Surgical treatment and approaches

Microdissection and resection of spinal meningiomas remain the gold standard for treatment. The steps involved in the resection of a dorsal meningioma are depicted in Figure 1. The primary and most effective treatment method is laminectomy with complete excision of the tumor. In our study, the predominant surgical procedure utilized was tumor resection via a posterior approach. Among 22 patients, 20 (91%) underwent complete excision of the tumor, while only 2 (9%) had subtotal excision. The rate of total tumor resection reported by various studies differs: Levy et al. [4] reported 82%, Roux et al. [3] reported 92.6%, and Solero et al. [5] reported 97%. Certain tech-nical difficulties in tumor resection, particularly due to ventral location in relation to the cord, were encountered. However, even in these challenging cases, tumor resection can be performed with meticulous microsurgical techniques. Recent advancements in neuroradiological and neuro-surgical techniques have significantly improved the outcomes of surgical treatment for spinal tu-mors. Postoperative results varied based on factors such as preoperative neurological status, tumor nature and location, and the type of surgical resection. Some authors suggested that epidural men-ingiomas [4]

and those situated close to a radicomedullary artery posed surgical challenges. There was a belief that spinal meningiomas with epidural extension exhibited a more rapid clinical course and were more invasive [4]. However, others argued that these lesions did not represent a unique subgroup and exhibited an indolent course [3, 5]. Roux et al. [3] cautioned against total re-section of spinal meningiomas near a radicomedullary artery that feeds the anterior spinal artery, citing it as a risky procedure. They advocated for the use of spinal angiography in all such cases.

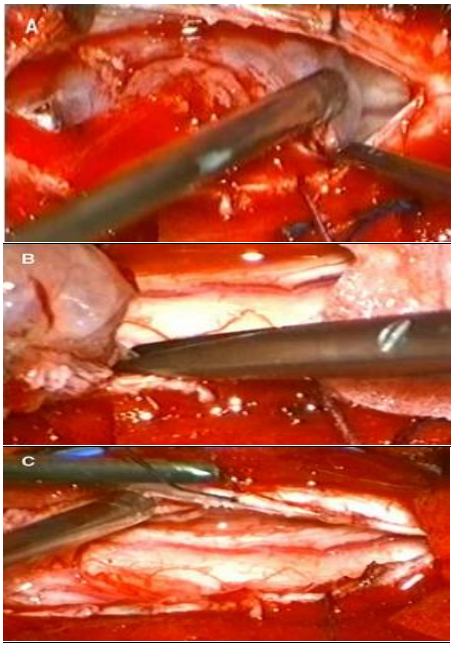

Figure 1. Intraoperative photographs showing the dorsal meningioma (a) after dura opening, (b) following complete resection including the dural attachment and (c) after tumor removal the ven-tral displacement of the spinal cord.

Tumor size and location

Spinal meningiomas are most observed in the thoracic region. In our study, the tumor was in the thoracic region in 15 patients (68.18%), cervicothoracic in 4 (18.18%), thoracolumbar in 2 (9%), and cervical in 1 (4.54%) of the patients. These findings are consistent with studies published in the literature [9, 29, 34, 35]. An example of a contrast MRI sagittal section showing a meningioma (arrow) at the T12-L1 level is presented in Figure 2. Namer IJ et al. reported 29 cases of spinal meningiomas, with 19 lesions in the thoracic regions and 10 in the cervical region [29]. Gezen F et al. reported that 55% of tumors were in the thoracic region [9]. The incidence of thoracic location was reported by Levy et al. as 75% [4], and by Roux et al. as 79.5% [3].

In our study, the size of the tumor ranged from 1 to 4 cm, with a mean greatest diameter of 2.9 cm. The tumor size was greater than 2 cm in 17 patients (77.27%) and less than 2 cm in 5 patients (22.72%). Namer IJ et al. noted that the size of the excised tumors varied between 1 x 1 cm and 4.5 x 1.5 cm [29]. An example of a T1-weighted axial contrast MRI scan displaying the ventro-lateral displacement of the spinal cord (arrow) due to tumor compression is depicted in Figure 3.

Figure 2. Contrast MRI sagittal section showing meningioma (arrow) at T12-L1 level.

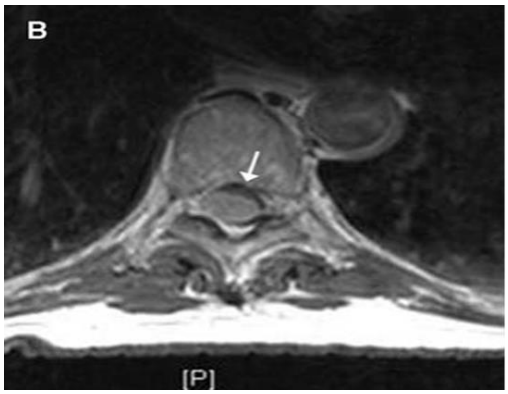

Figure 3. T1-weighted axial contrast MRI scan showing the ventro-lateral displacement of the spinal cord (arrow) due to tumor compression.

Postoperative complications

n our study, among 22 patients, only two (9.09%) experienced postoperative complications, which included one patient with a CSF leak and another with a wound infection. Gezen F et al. [9] ob-served postoperative complications in three patients, including one with cerebrospinal fluid leak-age and two with wound infections. Namer IJ et al. [29] reported postoperative complications in seven patients, with two patients (7%) experiencing wound infections, one patient (4%) with pul-monary infection, one patient (4%) with urinary infection, one patient (4%) with hematemesis, and one patient (4%) with thrombophlebitis. Unfortunately, one patient died on the 11th postoper-ative day. Gottfried ON et al. noted a low incidence of CSF leakage ranging from 0% to 4% [14].

Duration of hospital stay

In our study, the mean duration of postoperative hospital stay was 11 days. This duration was cal-culated from the day of surgery to the day of discharge. Patients who experienced postoperative complications tended to have longer hospital stays. The range of hospital stay duration varied from 5 days to 40 days.

Recurrence

In most series, the recurrence of spinal meningiomas is rare, with rates typically ranging from 1.3 to 6.4% [3-5, 9, 36, 37, 39]. Ketter et al. [37] reported that spinal meningiomas lack the genetic abnormalities found in recurrent intracranial meningiomas, indicating a more indolent nature for these tumors. The slow growth of spinal meningiomas and their occurrence in patients at an ad-vanced age contribute to the low recurrence rates [36]. In our study, only 2 out of 22 patients (9%) were observed to have experienced recurrence. The patient who underwent subtotal resection ex-perienced recurrence after 5 years, while the tumor that was completely resected recurred after 7 years. Long-term studies on spinal meningiomas, especially regarding late recurrences, are lim-ited. Levy et al. reported a late recurrence rate of 4% [4], while Solero et al. reported it as 1.3% [5]. Mirimanoff et al. [30] provided insight into recurrence-free rates after surgery. After total re-section, the rates were reported as 93%, 80%, and 68% at 5, 10, and 15 years, respectively. In con-trast, after subtotal resection, the progression-free rates were significantly lower at 63%, 45%, and 9% during the same periods.

Adjuvant therapy

While the preferred treatment for spinal meningioma is the complete removal of the tumor through microsurgery, Mirimanoff et al. [30] suggested considering radiotherapy as an additional treatment following subtotal excision. Radiotherapy can effectively manage unexcised or recur-rent meningiomas. However, the role of radiotherapy in treating spinal meningioma remains con-troversial due to the disease's slow progression and the potential harm caused by radiation. Gezen et al [9] reported no recurrence in two patients who underwent radiotherapy for recurrent spinal meningioma. Roux et al [3] also conducted radiosurgery in two patients with recurrences, and both patients remained stable during a follow-up examination after 5 years. The authors recommend radiotherapy in specific scenarios: early recurrence post-total or subtotal resection, situations where complete resection isn't feasible due to tumor location or the patient's medical condition, and instances where there's a high surgical risk. If early recurrence occurs, reoperation should pre-cede radiotherapy. In our study, adjuvant therapy in the form of radiotherapy was administered to one patient who experienced lesion recurrence after 5 years.

Conclusions

This study illustrates that spinal meningioma is a slow-growing tumor typically manifesting be-tween the fourth and fifth decades of life, with a female-to-male ratio of 2:1. Pain stands out as the most common symptom during presentation. Radiological investigations such as CT scans and MRI play a crucial role in providing a presumptive diagnosis of spinal meningioma, later con-firmed by histopathological examination. Surgery remains the primary treatment, albeit it may be complicated by postoperative issues like wound infection, CSF leak, or bowel/bladder dysfunc-tion. In cases of recurrence or advanced disease, adjuvant therapy in the form of radiotherapy can be considered for palliative purposes.

Declarations

Ethics approval and consent to participate: The study was assessed by the Institutional ethics committee of SKIMS and was considered exempt from review in accordance with the observa-tional study that was done. A written consent to participate in study was taken form the patient or guardian in case of minor.

Availability of data and material: N/A.

Competing interests: The authors declare that they have no competing interests.

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