

A Radiology-pathological Correlation of Spinal Meningioma in a Tertiary Care Hospital - A Retrospective Study

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Abstract

Introduction: The study was conducted to understand the clinical algorithm of spinal meningioma. Correlation was done by clinical presentation with radiological features and histopathology. The stress on to understand the necessity for a team-approach between clinician, radiologist and pathologist and vice versa is emphasized.

Aim: The aim of the study is to correlate histopathology of spinal meningioma with the radiological features.

Materials and Methods: This is a retrospective study of spinal tumors, diagnosed by histopathology as various types of meningioma. All the relevant clinical data of the patients were searched from the ward records. The various radiological features were collected.

Results: The total number of spinal tumors studied during the 8 years period was 86 cases among which 25 cases were diagnosed by histopathology as various types of meningioma conclusively. Spectroscopy provides molecular information with regard to meningiomas and potentially aid in biopsy planning. Surgical resections were done as follows: 20 cases resected as Simpson Grade 1, 5 cases resected as Simpson Grade 2. Venous thromboembolism was seen in 1 patient. Four cases underwent follow-up adjuvant external beam radiotherapy.

Conclusion: The Simpson grading of resection of meningioma correlated the degree of surgical resection completeness with symptomatic recurrence. Four cases underwent follow-up adjuvant external beam radiotherapy with good results. Spinal meningioma needs correlation between radiologist, pathologist and clinician.

Key words: Adjuvant external beam radiotherapy, Computed tomography, Hematoxylin-eosin stain, Magnetic resonance imaging, Radiograph, Simpson grading of resection

INTRODUCTION

Meningiomas, which arise from arachnoid cap (meningothelial) cells, are one of the most frequent primary intraspinal neoplasms is approximately five per million for females and three per million for males. Spinal meningiomas most often affect middle-aged women. The

second most common intradural extramedullary spinal tumor representing 25% of all such tumors. Meningiomas are often located posterolaterally in the thoracic region and anteriorly in the cervical region. We found that spinal meningiomas were located lateral to the spinal cord or had a component that extended laterally. A posterior location was more frequent than an anterior one. Typically, back or radicular pain preceded the weakness and sensory changes; the sphincter dysfunction was always a late finding. The incidence of meningioma is due to exposure to environmental risk factors or sensitive diagnostic modalities; there is a relationship between age, sex, pathological subtype, and location of meningioma.¹ An estimated 0.5% of the population has an incidental asymptomatic spinal meningioma in autopsy studies.² With the wider

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Month of Submission : 05-2017
Month of Peer Review : 06-2017
Month of Acceptance : 07-2017
Month of Publishing : 07-2017

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use of computed tomography and magnetic resonance imaging (MRI), many meningiomas are discovered as incidental findings during investigation for unrelated symptoms.³ Sex, age, initial tumor size, and calcification were reported to be related to the tumor growth judging from follow-up scans.⁴ Ginkgo leaf sign is seen on axial post contrast T1 imaging, with the leaf representing the distorted spinal cord, pushed to one side of the theca by the meningioma, and the stem, seen as a non-enhancing “streak,” probably representing the stretched dentate ligament.⁵ The prevalence of tumor invasion of the dural tail has been reported (0-100%), with generally higher prevalence in the World Health Organization (WHO) II (atypical) meningiomas.⁶ This is further complicated by the presence of tumor cells in apparently normal dura adjacent to tumors. Whether or not the dural tail should be resected and if so how much surrounding dura should be included in the resection continues to be debated.⁷ A broad division of meningiomas is into primary intradural (which may or may not have secondary extradural extension) and primary extradural pregnancy is associated with high incidence of spinal meningioma.⁸ Intradural extramedullary neoplasms are located outside the spinal cord but within the dural sheath. Extradural spinal meningioma arises outside the dural covering of the spinal cord. Meningiomas are categorized into three WHO grades with 16 histological subtypes. Meningiomas are closely associated with the tumor suppressor syndrome NF2, with 50-75% of individuals with NF2 developing a meningioma during their lifetime, associated with obesity.⁹ Meningiomas are the most common extraaxial primary spinal tumor.¹⁰ Although a majority of these tumors are low grade, a significant proportion will recur after initial treatment.¹¹ Literature published since the WHO 2000 classification report higher recurrence rates at 5 years following surgical excision for WHO Grade 2 (41%),¹² and 70-91% for Grade 3 (than for WHO Grade 1 lesions (3%). Primary intraosseous meningioma is a term used to describe a subset of these extradural meningiomas that arise in bone.¹³ The second most common intradural extramedullary spinal tumor representing 25% of all such tumors.¹⁴

Aim

The aim of the study is to correlate histopathology of spinal meningiomas with the radiological features.

MATERIALS AND METHODS

This retrospective study was conducted in the Department of Pathology, Thoothukudi Medical College Hospital. We reported 86 cases of primary spinal tumors among which 25 cases were various types of spinal meningioma by histopathology conclusively. All the relevant clinical

data of the patients were searched from the ward records. Parameters used to assess were age, sex, tumor location, pathological subtype, Simpson grade of surgical excision, tumor recurrence or progression during follow-up, venous thromboembolism (VTE) in the follow-up period survival time. A detailed health profile on general condition was taken and recorded.

RESULTS

Meningioma commonly involved thoracic region and cervical regions in the study. Meningothelial meningioma and psammomatous meningioma were the common subtypes observed (Table 1).

T1 weighted MRI scan shows meningioma as an isointense lesion; contrast enhanced T1 weighted scan shows enhancement of the lesion and T2 weighted scan shows meningioma as a high signal intensity lesion. The histopathological finding varies with the grades (Table 2).

Meningioma

Meningiomas occur most commonly after the fifth decade of life. Females are affected far more commonly than males in ratio of 4:1. The gross appearance of the typical meningioma is a solid, lobulated, or globose mass broadly attached to the dura mater. On sectioning, most meningiomas are grayish-tan and soft, but collagenized, have a rubbery texture and a whorled or trabeculated cut surface, whereas variants rich in stromal mucopolysaccharides acquire a somewhat gelatinous consistency. Calcification is often readily apparent and infiltration by foamy macrophages reflects the accumulation of lipids within tumor cells. Factors that may influence the etiology of peritumoral edema include tumor size, histological subtypes, vascularity, venous stasis, and dural invasion. Loss of chromosome 22 occurs in recurrent and atypical meningiomas. Approximately, half of meningiomas exhibit allelic loss that involves band q12 on chromosome 22.

The NF2 gene that resides in this region on chromosome 22q is a tumor suppressor gene involved in sporadic and

Table 1: Distribution of tumor locations and histopathological subtypes of spinal meningioma

Types	Cervical	Thoracic	Lumbar	Sacral	Total
Meningothelial	1	6	0	0	7
Fibrous	1	2	0	0	3
Transitional	1	2	0	0	3
Angiomatous	1	1	0	0	2
Psammomatous	1	6	0	0	7
Atypical	0	2	0	0	2
Anaplastic	0	1	0	0	1
Total	5	20	0	0	25

Table 2: Correlation study of spinal meningioma

Tumor	Radiographic findings	Histopathological findings
Meningothelial meningioma	MRI scan shows an extradural mass with dural tail extending above and below it results in marked compression of the upper thoracic cord	Sections studied show meningothelial meningioma displaying a more relaxed fascicular and syncytial arrangements. Psammomatous calcifications can be appreciated in the center of the image. Fine collagenous septae appear intertwined with meningothelial cells
Fibroblastic meningioma	MRI scan shows a vividly-enhancing T2 hyperintense lobulated intradural extramedullary tumor centered in the left side of the spinal canal at the C5/6 vertebral level, with enhancement extending along the exiting left C6 nerve root. The tumor severely compresses and displaces the spinal cord into the right side of the spinal canal at this level	Section studied shows fibrous meningioma containing ropey collagen. The collagen fibers look brighter and thickened intertwined with meningothelial cells bundles
Transitional meningioma	MRI scan shows a dural-based mass, located posterior to the thoracic cord, markedly compressing it. It is isointense to cord tissue on both T1 and T2 weighted images, and demonstrates vivid contrast enhancement. Dural tails are seen extending above and below the lesion	Section studied shows features of both meningothelial and fibrous types. The meningothelial cells arranged in fascicles of variable length and also exhibit some lobularity
Angiomatous meningioma	MRI scan shows an extramedullary, oval lesion at T10/11 level. It is isointense on T1 and there is moderate enhancement. The spinal cord is displaced anteriorly. The coronal view shows the lesion displacing the cord to left. The lesion measures 13 mm×8 mm	Section studied shows numerous vascular spaces can be identified in the background of meningothelial cells
Atypical meningioma	MRI scan shows a lesion within the spinal canal at T9 is a slightly hyperintense on T1, isointense on T2 intensely enhancing extramedullary intradural mass. The lesion displaces the spinal cord toward the right with complete effacement of the CSF signal at this level and significant cord compression	Section studied shows the classic concentric calcifications. Psammomatous meningiomas need to have over half of the tumor mass composed of psammoma bodies and underlying meningothelial cells
Anaplastic meningioma	MRI scan shows a well-defined enhancing intradural, extramedullary mass at the T2/T3 level causing severe compression. High signal foci in the cord in keeping with compression related edema	Section studied shows atypical meningioma, with hypercellularity, increased mitotic activity and macronucleoli

MRI: Magnetic resonance imaging, CSF: Cerebrospinal fluid

NF2-associated meningioma tumorigenesis. Mutations in NF2 gene are associated with sporadic meningioma, fibrous meningioma, transitional meningioma, meningothelial meningioma, atypical and anaplastic meningiomas.

Behavior is coded/0 for benign tumors,/1 for low or uncertain malignant potential or borderline malignancy,/2 for *in situ* lesions, and/3 for malignant tumors (Table 3).

Treatment for Intracranial Meningioma

Surgery for spinal meningioma

The prone position for all spinal tumors, including those in the cervical region. It is important to localize the correct level by X-ray. In cases in which meningiomas were located anteriorly, the laminectomy was extended laterally toward the articular process to provide sufficient exposure and cause minimal displacement underwent classic posterior of the spinal cord. The key considerations in the operation include the following. Adequate exposure above and below the tumor and on the ipsilateral side is needed. Careful removal of laminae is important particularly when there is an indication that the tumor is calcified. This may be facilitated by drilling a groove at the lateral edge of the

lamina on each side and then lifting the lamina up while the yellow ligament attachments are divided. The dura is opened laterally over the tumor. Internal and/or lateral decompression of the tumor is performed before trying to dissect the tumor away from the spinal cord. Division of the dentate ligament attachments and/or a posterior nerve root in the thoracic region may facilitate removal. When the tumor is posterior lateral, the dural attachment is excised and the defect is repaired with a piece of fascia. In the more common anterior lateral tumors, resection of dura may be difficult without risk of injury to the ventral nerve roots or spinal cord. Calcified meningiomas were also difficult to resect because of adhesions to the spinal cord. Excellent results have been reported by several neurosurgeons using microsurgical techniques. Laminectomy is replaced by osteoplastic laminotomy with reconstruction of the posterior spinal column. The dural attachment was completely resected if the spinal meningioma was located dorsally or dorsolaterally. In these cases, duraplasty was performed with autologous fascia obtained during the operative approach. In ventrally located tumors, the dural attachment was not excised but extensively bipolar cauterized. Somatosensory evoked potentials were routinely

monitored in each of the patients. Patients with malignant meningiomas underwent external-beam radiation therapy alone or in combination with chemotherapy after surgery. Cerebrospinal fluid (CSF) leakage, wound complications, and transient deterioration of neurological status were the most common post-operative complications. The most frequent cause of death during the post-operative period was pulmonary embolism.

The Simpson grade of meningioma resection was described in 1957 and correlated the degree of surgical resection completeness with symptomatic recurrence. The type of resection still plays a part in the likelihood of symptomatic recurrence, other factors (such as the MIB-1 index) are also important, particularly in Grades 1-3 (Table 4).

Adjuvant Radiotherapy

Conventional external beam radiotherapy lacks the precision to allow delivery of large doses of radiation near radiosensitive structures such as the spinal cord. Tumor dose was maintained at 12-20 Gy. The CyberKnife system was found to be feasible, safe, and effective. The major potential benefits of radiosurgical ablation of spinal lesions are short treatment time in an outpatient setting with rapid recovery and symptomatic response. This technique offers a successful therapeutic modality for the treatment of a variety of spinal lesions as a primary treatment or for lesions not amenable to open surgical techniques, in medically inoperable patients, in lesions located in previously irradiated sites, or as an adjunct to surgery.

Chemotherapy for Meningioma

- Hydroxyurea - Hydroxyurea is an oral ribonucleotide inhibitor that arrests the cell cycle in the S phase and induces apoptosis. Investigators are currently looking at the role of hydroxyurea as an adjunct to other therapies, such as radiation or calcium channel blockers. Pilot studies with radiation have shown some promise
- Trabectedin - This chemotherapeutic agent is believed to work by binding to the minor groove of the DNA helix and inhibiting transcription factor binding. Trabectedin was investigated in a preclinical study published by Preusser *et al.*, which revealed a statistically significant response to treatment of various meningioma cell lines. The group subsequently treated a single, heavily pretreated patient with this chemotherapeutic agent was reported to have initial relief of his neurological symptoms and aphasia, and MRI revealed reduction of perifocal edema; however, treatment had to be terminated after five cycles due to side effects of generalized edema and mucositis. Additional, combinations of adriamycin and decarbonize or isosfamide and mensa showed efficacy in some cases.

Table 3: Morphology code of the ICD-O of intracranial meningioma

Disease	Code
Meningothelial meningioma	9531/0
Fibrous (fibroblastic) meningioma	9532/0
Transitional (mixed) meningioma	9537/0
Psammomatous meningioma	9533/0
Angiomatous meningioma	9534/0
Microcystic meningioma	9530/0
Secretory meningioma	9530/0
Lymphoplasmacytic-rich meningioma	9530/0
Metaplastic meningioma	9530/0
Clear cell meningioma	9538/1
Chordoid meningioma	9538/1
Atypical meningioma	9539/1
Papillary meningioma	9538/3
Rhabdoid meningioma	9538/3
Anaplastic meningioma	9530/3

ICD-O: International Classification of Diseases for Oncology

Table 4: The Simpson grade of meningioma resection

Simpson grade	Definition	10-year recurrence rate (%)
1	Macroscopic gross-total resection with excision of dura, sinus, and bone	9
2	Macroscopic gross-total resection with coagulation of dural attachment	19
3	Macroscopic resection without resection or coagulation of dural attachment	29
4	Subtotal resection	40
5	Biopsy	Not available

Meningotheliomatous Meningioma

Seven cases of meningotheliomatous meningioma were reported. Six cases involving females and one case involving males. The age group involved in females range from 56 to 74 years of age old and the age involved in male was 59 years of age old. Six cases involved cervical region, one involved thoracic region and one case involved thoracic region. Six cases underwent Simpson Grade 1 resection and one case underwent Simpson Grade 2 resection one case underwent Adjuvant external beam radiotherapy microscopically meningotheliomatous meningioma variants are the classic and common variant characterized by a lobular microarchitecture and are populated by cells having delicate round or oval nuclei. Common to these are tumor cells concentrically wrapped in tight whorls, pale nuclear "pseudoinclusions," and nuclear "washing out" consisting of invaginated cytoplasm, and the lamellated calcospherules known as psammoma bodies.

Extradural mass with dural tail extending above and below it results in marked compression of the upper thoracic cord.

Sections studied show meningotheial meningioma displaying a more relaxed fascicular and syncytial arrangements. Psammomatous calcifications can be appreciated in the center of the image. Fine collagenous septae appear intertwined with meningotheial cells. MRI scan shows an extradural mass with dural tail extending above and below it results in marked compression of the upper thoracic cord. The histopathology and radiology correlation was perfect in all the seven cases (Figures 1 and 2).

Fibroblastic Meningioma

Three cases of fibroblastic meningioma were reported, two cases involving females and one involving males. The age group involved in females range from 52 to 67 years of age old and the age group involved in males 72 years of age old. Two cases involved thoracic region, one involved thoracic region. All three cases underwent Simpson Grade 1 resection. Fibroblastic meningioma is a common variant adopt a mesenchymal profile, being variably collagenized and consisting of spindle-shaped tumor cells in interfascicular pattern. In fibroblastic meningioma, the tumor cells form wide fascicles, with intercellular collagen and reticulin. The collagenous bands may be quite broad and may undergo dense calcification.

A vividly-enhancing T2 hyperintense lobulated intradural extramedullary tumor centered in the left side of the spinal canal at the C5/6 vertebral level, with enhancement extending along the exiting left C6 nerve root. The tumor severely compresses and displaces the spinal cord into the right side of the spinal canal at this level, with no overt cord signal abnormality demonstrated.

Section studied shows fibrous meningioma containing ropey collagen. The collagen fibers look brighter and thickened intertwined with meningotheial cells bundles. MRI scan shows a vividly-enhancing T2 hyperintense lobulated intradural extramedullary tumor centered in the left side of the spinal canal at the C5/6 vertebral level, with enhancement extending along the exiting left C6 nerve root. The tumor severely compresses and displaces the spinal cord into the right side of the spinal canal at this level. The histopathology and radiology correlation was perfect in all the three cases (Figures 3 and 4).

Transitional Meningioma

Three cases of fibroblastic meningioma were reported. Three cases involving females and one involving male. The age group involved in females range from 56 to 68 years of age old and the age group male is 67 years of age old. Two cases involved thoracic region, one involved cervical region. All three cases underwent Simpson Grade 1 resection. Microscopically these tumors have transition between

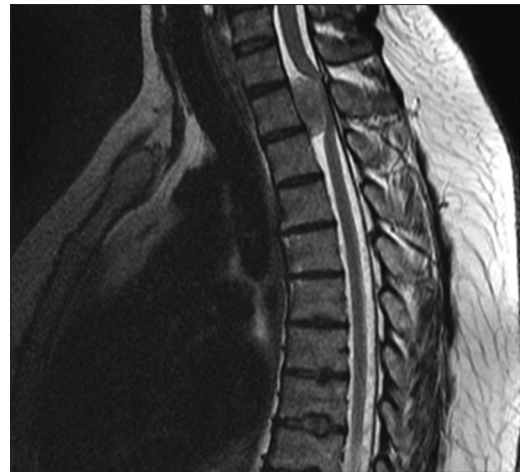


Figure 1: Meningotheial meningioma displaying a more relaxed fascicular and syncytial arrangements. Psammomatous calcifications can be appreciated in the center of the image. Fine collagenous septae appear intertwined with meningotheial cells

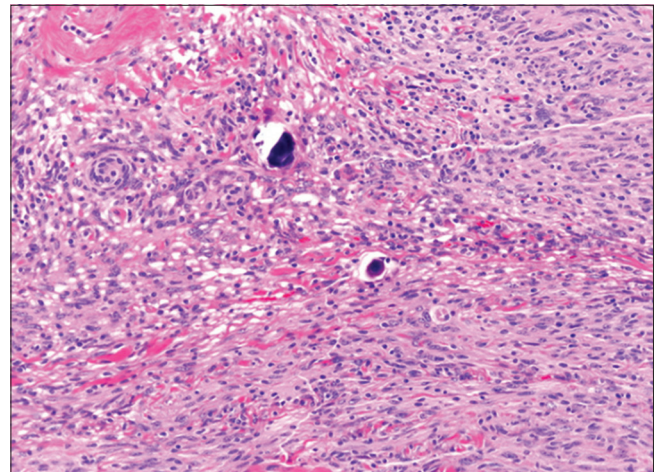


Figure 2: Sections studied show meningotheial meningioma displaying a more relaxed fascicular and syncytial arrangements

meningotheial and fibrous meningioma. They maintain a lobular and fascicular arrangement. Whorls are striking and are tightly wound. These are often particularly rich in compact cellular whorls and endowed with psammoma bodies in significant numbers. Some tumors have large, distinct areas of meningotheial, fibrous and transitional regions mingle locally.

A dural-based mass is located posterior to the thoracic cord, markedly compressing it. It is isointense to cord tissue on both T1 and T2 weighted images, and demonstrates vivid contrast enhancement. Dural tails are seen extending above and below the lesion.

Section studied shows features of both meningotheial and fibrous types. The meningotheial cells arranged in fascicles of variable length and also exhibit some lobularity. MRI

scan shows a dural-based mass, located posterior to the thoracic cord, markedly compressing it. It is isointense to cord tissue on both T1 and T2 weighted images, and demonstrates vivid contrast enhancement. Dural tails are seen extending above and below the lesion. The histopathology and radiology correlation was perfect in all the three cases (Figures 5 and 6).

Angiomatous Meningioma

Two cases of angiomatous meningioma were reported. One case involving female and one involving male. The age group involved in female is 62 years of age old and the age group involved in male 56 years of age old. One case involved cervical region, one involved thoracic region angle. All two cases underwent Simpson Grade 1 resection. One case underwent follow-up stereotactic radiosurgery (SRS). Microscopically these tumors have numerous, conspicuous blood vessels with regions of classical meningothelial meningioma. The vascular channels may be small, medium sized and may be thin walled or have hyalinized thickened walls.

There is an extramedullary, oval lesion at T10/11 level. It is isointense on T1 and there is moderate enhancement. The spinal cord is displaced anteriorly. The coronal view shows the lesion displacing the cord to the left. The lesion measures 13 mm × 8 mm.

Section studied shows numerous vascular spaces can be identified in the background of an meningothelial cells. MRI scan shows an extramedullary, oval lesion at T10/11 level. It is isointense on T1, and there is moderate enhancement. The spinal cord is displaced anteriorly. The coronal view shows the lesion displacing the cord to the left. The lesion measures 13 mm × 8 mm. The histopathology and radiology correlation was perfect in all the two cases (Figures 7 and 8).

Psammomatous Meningioma

Seven cases of meningotheliomatous meningioma were reported. Six cases involving females and one case involving male. The age group involved in females range from 56 to 74 years of age old and the age involved in male was 59 years of age old. Six cases involved cervical region, one involved thoracic region and one case involved thoracic region. Six cases underwent Simpson Grade 1 resection and one case underwent Simpson Grade 2 resection one case underwent adjuvant external beam radiotherapy psammomatous meningioma is a histologic subtype of meningioma usually presented as a heavily calcified intracranial or spinal mass lesion. Microscopically these meningiomas have abundant psammoma bodies; the neoplastic cells have a transitional appearance with whorls. As psammoma bodies become large, they may lose circular

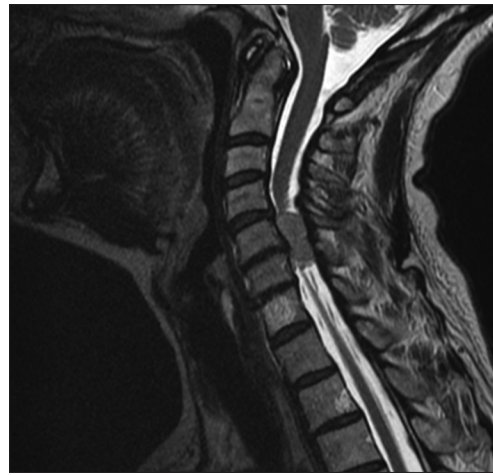


Figure 3: Fibrous meningiomas usually contain ropey collagen that may mimic the appearance of solitary fibrous tumor. In this image, the collagen fibers look brighter and thickened intertwined with meningothelial cells bundles

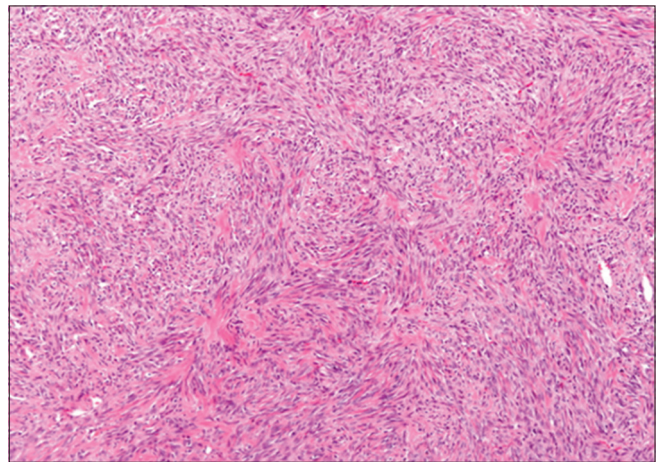


Figure 4: Section studied shows fibrous meningioma containing ropey collagen

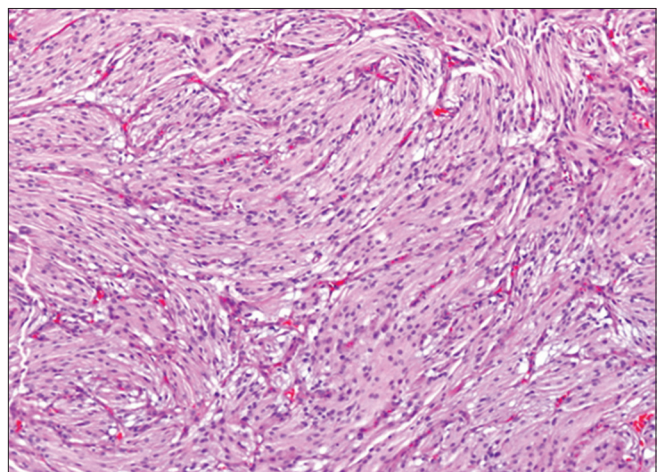


Figure 5: Transitional meningioma sections show features of both meningothelial and fibrous types. The meningothelial cells arranged in fascicles of variable length and also exhibit some lobularity

shape and assume less regular shapes. They occur in the thoracic spinal region particularly in middle-aged women.

Within the spinal canal at T9 is a slightly hyperintense on T1, isointense on T2 intensely enhancing extramedullary intradural mass measuring 10 mm × 13 mm × 16 mm in orthogonal planes. The lesion displaces the spinal cord toward the right with complete effacement of the CSF signal at this level and significant cord compression.

Psammomatous meningioma demonstrating the classic concentric calcifications. Psammomatous meningiomas need to have over half of the tumor mass composed of psammoma bodies. They probably start out as transitional meningioma that over time undergoes calcification obscuring the underlying meningothelial cells.

Section studied shows the classic concentric calcifications with underlying meningothelial cells. MRI scan shows a lesion within the spinal canal at T9 is a slightly hyperintense on T1, isointense on T2 intensely enhancing extramedullary intradural mass. The lesion displaces the spinal cord toward the right with complete effacement of the CSF signal at this level and significant cord compression. The histopathology and radiology correlation was perfect in all the seven cases (Figures 9 and 10).

Atypical Meningioma

An atypical meningioma is more common in women of middle age or above 50 years of age. Microscopically atypical meningioma is characterized by multifocal, centrilobular forms of necrosis creating a low power microscopic impression similar to the pseudo palisading of tumor cells around necrosis. The absence of architectural pattern is referred to as “sheeting.” Regions of hypercellularity and high nuclear: Cytoplasmic ratio is seen in atypical meningioma. One finds irregular, small islands of dense cellularity with hyperchromatic nuclei and relatively inconspicuous cytoplasm otherwise called “small cell formation.” The estimated recurrence rate for totally resected atypical meningiomas is about 40% at 5 years. Any of the following three criteria microscopically should be demonstrated for a diagnosis.

1. High mitotic index (e.g., ≥ 4 mitoses per 10 high-power fields or $\geq 2.5/\text{mm}^2$)
2. Presence of at least three of the following four features:
 - i. Sheeting architecture
 - ii. Hypercellularity
 - iii. Macro nucleoli
 - iv. Small cell formation.
3. Brain invasion

Two cases of atypical meningioma were reported, one case involving female and one involving male. The age



Figure 6: A dural-based mass is located posterior to the thoracic cord, markedly compressing it



Figure 7: Magnetic resonance imaging scan shows an extramedullary, oval lesion at T10/11 level

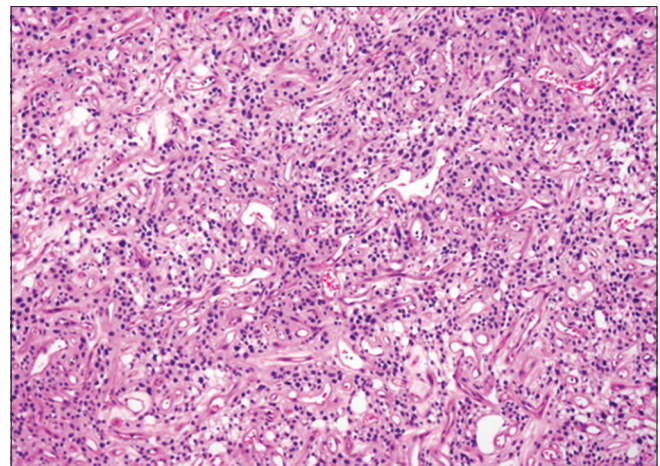


Figure 8: Numerous vascular spaces can be identified in the background of an ordinary meningioma

group involved in female is 67 years of age old and the age group involved in male 56 years of age old. One cases

involved cervical region, one involved thoracic region. All two cases underwent Simpson Grade 2 resection. Two cases underwent follow-up adjuvant external beam radiotherapy.

Well defined enhancing intradural, extramedullary mass at the T2/T3 level causing severe compression. High signal foci in the cord in keeping with compression related edema.

Section studied shows atypical meningioma, with hypercellularity, increased mitotic activity and macro nucleoli. MRI scan shows a well-defined enhancing intradural, extramedullary mass at the T2/T3 level causing severe compression. High signal foci in the cord in keeping with compression related edema. The histopathology and radiology correlation was perfect in all the two cases (Figures 11 and 12).

Anaplastic Meningioma

Anaplastic malignant meningioma microscopically shows pattern less sheet such as growth, a large number of mitoses, increased cellularity, focal necrosis, brain infiltration, pleomorphism, and anaplasia. Anaplastic meningiomas are associated with recurrence rates of up to 50-80% after surgical resection and median survival is <2 years. One case of anaplastic meningioma was reported. The age group involved in female case is 68 years of age old. One case involved thoracic region. One case underwent Simpson Grade 2 resection. One case died due to VTE in the post-operative period. MRI showed that the lesion had a slightly short T1 signal and a long T2 signal in addition to a conspicuous heterogeneous enhancement with contrast administration on T1-weighted images.

A dural-based mass lesion in the upper thoracic spine with same signal intensity as that of spinal cord with displacement of cord to the right. Homogeneous enhancement with contrast.

Section studied shows the tumor displays hypercellularity, prominent nucleoli, nuclear pleomorphism, and sarcoma-like morphology. MRI scan shows a dural-based mass lesion in the upper thoracic spine with same signal intensity as that of spinal cord with displacement of cord to the right. Homogeneous enhancement with contrast. The histopathology and radiology correlation was perfect in all the one case (Figures 13 and 14).

MRI scans were obtained at pre-defined intervals, every 6 months for the 1st year and then yearly thereafter.

The Grade 1 tumors meningothelial meningioma, psammomatous meningioma, fibroblastic

meningioma, transitional meningioma, angioblastic meningioma responded well to treatment. The atypical



Figure 9: Section studied shows the classic concentric calcifications with underlying meningothelial cells

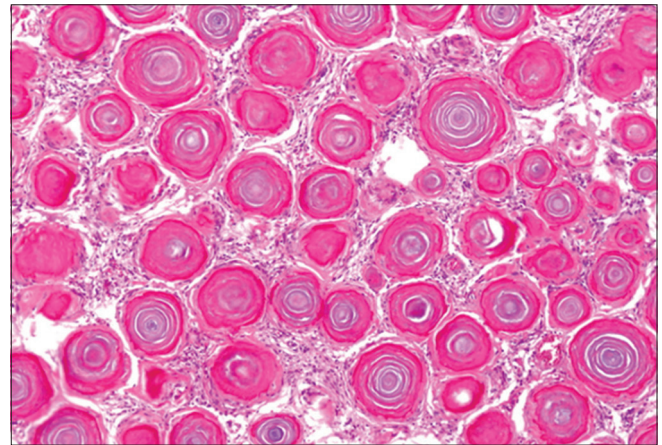


Figure 10: Magnetic resonance imaging scan shows a lesion within the spinal canal at T9 is a slightly hyperintense on T1, isointense on T2 intensely enhancing extramedullary intradural mass

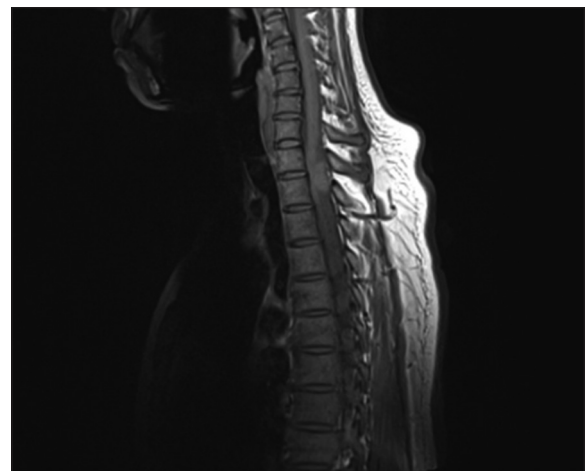


Figure 11: Atypical meningioma, WHO Grade 2 with hypercellularity, increased mitotic activity and macro nucleoli

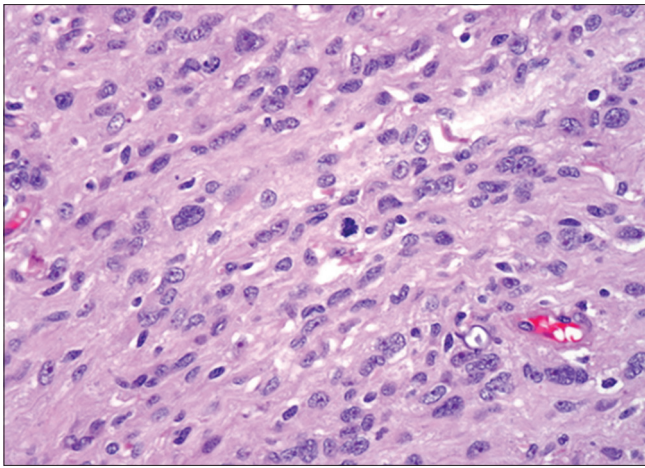


Figure 12: Section studied shows atypical meningioma, with hypercellularity, increased mitotic activity and macro nucleoli



Figure 13: The tumor displays hypercellularity, prominent nucleoli, nuclear pleomorphism, and sarcoma-like morphology

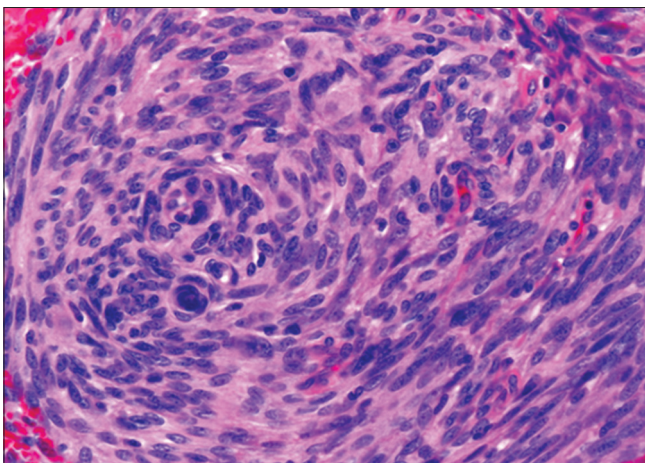


Figure 14: Section studied shows the tumor displays hypercellularity, prominent nucleoli, nuclear pleomorphism, and sarcoma-like morphology

meningioma and anaplastic meningioma did not respond to treatment (Table 5).

DISCUSSION

Our study has similar findings with the literature including female predominance and age distribution.¹⁵⁻¹⁹ One patient experienced VTE and died because of pulmonary embolism. Meningothelial and psammomatous meningiomas were the most common pathological subtypes of meningiomas. Based on the hypothesis, that the diffusion of water to and from the cells is highly dependent on the ratio of intracellular and extracellular space, DWI MRI Scan is used to differentiate the tumour grades.²⁰⁻²² Pathological examination revealed irreversible changes, including atrophy of the anterior horn, disappearance and necrosis of anterior horn cells in the grey matter, and demyelination and axonal degeneration in the white matter.²³ High-grade meningiomas are characterized by restriction of the water diffusion; depicting as hyperintensity on DWI. Spectroscopy MRI Scan provides molecular information with regard to meningiomas and potentially aid in biopsy planning. In males, they are more likely to experience recurrence. The presence of a dural tail should be carefully analyzed in predicting recurrence. Patients exhibiting a dural tail on imaging need undergo long-duration follow-up, as late recurrence is a known phenomenon in large tumors with ventral attachment causing spinal cord compression. As suggested by some authors²⁴ arachnoid scarring can also cause secondary progressive neurological deterioration after spinal intradural surgery. As early as 1938, spinal meningioma surgery was described by Cushing and Eisenhardt²⁵ as being “one of the most gratifying of all operative procedures.” When analyzed all pathological subtypes, the poor prognosis was found in anaplastic meningiomas, followed by atypical meningiomas. Stereotactic radiosurgery is a safe and effective treatment for spinal meningiomas with or without surgical resection. The following factors were prognostically positive: Early diagnosis before the appearance of severe neurological symptoms, young age of the patients, total removal of the tumor, mild spinal cord compression, no intraoperative spinal cord retraction because of adequate surgical access, and the use of microsurgical techniques.

CONCLUSION

Group I meningioma demonstrated benign radiological, histopathological and clinical behavior; Group III demonstrated aggressive radiological, histopathological, and clinical behavior. Group II meningioma might be considered intermediate. Pre-operative radiological classification can be used as a supplement to the histopathological grading. Adjuvant therapies like SRS can be beneficial for spinal meningiomas with severe

Table 5: Final outcome of the study

Tumor	Surgery done	Cure rate (%)	Follow-up
Meningothelial meningioma	Six cases underwent Simpson Grade 1 resection and one case underwent Simpson Grade 2 resection one case underwent adjuvant external beam radiotherapy	100	Seven cases are attending follow up
Fibroblastic meningioma	Three cases underwent Simpson Grade 1 resection	100	Three cases reported for follow-up
Transitional meningioma	Three cases underwent Simpson Grade 1 resection	100	Three cases reported for follow-up
Angiomatous meningioma	One case underwent Simpson Grade 1 resection one case underwent Simpson Grade 2 resection. One case underwent follow-up adjuvant external beam radiotherapy	100	Two cases reported for follow-up
Psammomatous meningioma	Six cases underwent Simpson Grade 1 resection and one case underwent Simpson Grade 2 resection one case underwent adjuvant external beam radiotherapy	100	Seven cases turned for follow-up
Atypical meningioma	All two cases underwent Simpson Grade 2 resection. Two case underwent follow-up adjuvant external beam radiotherapy	-	No cases reported for follow-up after 1 year
Anaplastic meningioma	One case underwent Simpson Grade 2 resection. One case died due to VTE	-	Nil
Total	25 cases underwent surgery. Four cases underwent follow-up adjuvant external beam radiotherapy		22 cases turned for follow-up

VTE: Venous thromboembolism

spinal cord compression as total resection of those meningiomas may cause functional loss and they tend to be more benign. The planned combination of microsurgery and adjuvant gamma knife radiosurgery extends the therapeutic spectrum in the treatment of spinal meningiomas. Through our experience with patients suffering from severe preoperative neurological deficits, we can conclude that a good functional outcome should be expected in the vast majority of cases and that more than half of patients recovered totally after surgery. The study provides the importance of other medical faculty the surgeon, radiologist and oncologist to work as a team for a successful outcome. We correlated the histopathological findings with radiological findings. This resulted in perfect correlation between the histopathology study and radiology study.

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How to cite this article: Krishnaveni AG, Kannan P, Anandan H. A Radiology-pathological Correlation of Spinal Meningioma in a Tertiary Care Hospital - A Retrospective Study. Int J Sci Stud 2017;5(4):108-118.

Source of Support: Nil, **Conflict of Interest:** None declared.