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Original Research Article

Association of radiological type of dural tail sign in contrast MRI with histopathological grading of intracranial meningiomas

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ABSTRACT

Background: In neurosurgical practice meningiomas are one of the commonest intracranial tumors to seek surgical intervention which is classified into 3 histological grades and 15 subtypes according to the 2016 WHO classification of tumors of the CNS. The aim of this study was to evaluate the association between radiological type of dural tail sign in contrast MRI with histopathological grading of intracranial meningiomas.
Methods: This was a cross sectional interventional study carried out in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Dhaka Medical College Hospital and National Institute of Neuroscience Hospital including 35 patients of intracranial meningiomas who fulfilled the selection criteria were enrolled in this study.
Results: This study included 35 cases of intracranial meningiomas. There were 22 individuals (62.9%) in the 28-47 age group. The mean±standard deviation (SD) age of the participants was 45.97±9.56 years. There were 9 male participants (25.7%) and 26 female participants (74.3%) with ratio 1:3. We see that parasagittal location (50%) and sphenoid wing (33.3%) were more prevalent in grade II. We found significant distribution of the types of DTS among the histological grades of meningioma. The nodular cases (6,100%) were all grade II type. Mixed type was the most prevalent type among grade I.
Conclusions: There is association of radiological type of dural tail sign in contrast MRI with histopathological grading of intracranial meningiomas and may be used as a good tools for forecasting tumor type and prognosis.

Keywords: Asymmetrical multipolar, Histopathological grade, Meningioma, Nodular hyperplasia, Tumor morphology

INTRODUCTION

Meningiomas are one of the commonest intracranial tumors. It was named by Harvey Cushing in 1922.[1] They are common in adult age group and have a female predominance.[2] The incidence varies from 13-26% of all primary intracranial tumors.[3] Meningiomas arise from the arachnoid cap cells in the arachnoid villi and may affect both the skull vault and base.[4] Meningiomas are classified into 3 histological grades and 15 subtypes according to the 2016 WHO classification of tumors of the CNS. Grading was done as benign, atypical and anaplastic.[5] Meningothelial, fibroblastic, transitional, psammomatous,

angiomatous, microcystic, secretory, lymphoplasmacyte rich are in grade I. Atypical, chordoid and clear cell meningiomas are included in grade II. Anaplastic, Papillary and Rhabdoid meningiomas are classified as grade III.[6] The presentation of meningiomas depends upon their location and size. Meningiomas are typically not fast growing or infiltrative lesions and they have an insidious symptom onset. While there is no definitive presentation of meningioma, clinical symptoms of headache due to increased intracranial pressure, focal neurological deficits or generalized and partial seizures caused by focal mass effect, are typical. Personality changes, confusion and altered level of consciousness can be seen in anterior (frontal) or parasagittal meningiomas, and they may be initially misdiagnosed as dementia or depression. The differential diagnosis of a patient presenting with such symptoms is broad and should include other intracranial lesions (such a glioma or metastatic tumors).[5] For an accurate preoperative diagnosis and assessment of morphological appearances and relationship to surrounding structures, various imaging modalities are available. CT scan is used most commonly for diagnosis and to detect any bony abnormalities like hyperostosis.[7] But magnetic resonance imaging (MRI) has more accuracy in diagnosing meningiomas with better delineation of surrounding structures including dura.[7] On MRI, meningiomas are variable in intensity due to consistency, fibrosis, vascularity, necrosis and histological cell types. On contrast enhanced MRI homogenously contrast enhanced dural tail sign found commonly.[8] Dural tail sign (DTS) is considered the hallmark for the radiological diagnosis of a meningioma. It is seen in 60-72% cases of meningiomas.[9] Dural tail sign (DTS) also named as dural thickening‘ or meningeal sign‘ denotes thickening of dura adjacent to an intracranial meningioma on contrast enhanced MRI images which is due to tumor infiltration or vessel dilation or reactive changes.[10] A radiological typing of dural tail sign is being established. Based on MRI findings, the DTS was classified into 5 types: smooth, nodular, mixed, symmetrical multipolar and asymmetrical multipolar.[10] Several attempts were made previously to find out any association between dural tail sign and histopathological grading of intracranial meningiomas. But dural tail sign commonly found in all types of meningiomas.[10] So, further study and categorization of DTS is needed depending on its physical morphology. Aim of our study was to categorize DTS and search an association between this typing and histopathological grading.

The objective of this study was to evaluate the association between radiological type of dural tail sign in contrast MRI with histopathological grading of intracranial meningiomas.

METHODS

It was a cross-sectional interventional type of study. The study was carried out at the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka. I also recruited my cases from: Department of Neurosurgery, Dhaka Medical College and Hospital, Dhaka, Department of Neurosurgery, National Institute of Neurosciences and Hospital, Dhaka. This study was conducted from March 2022 to September 2023. Thirty five patients meeting the inclusion criteria were enrolled in the study to achieve an adequate sample size for robust statistical analysis. The study population included all patients diagnosed as a case of intracranial meningioma with fulfilling the selection criteria and underwent surgery at the Departments of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Dhaka Medical College and Hospital, Dhaka and National Institute of Neurosciences Hospital, Dhaka. Patients with incomplete imaging or histopathological data, as well as those with significant medical comorbidities that could affect the interpretation of results, were excluded to ensure the robustness of the analysis. A purposive sampling technique was used, and patients who fulfilled the selection criteria were included. A sample size 27 achieves 80.595% power to detect a difference (P1-P0) of 0.2000 using a two- sided Z-test that uses S(P0) to estimate the standard deviation with a significance level (alpha) of 0.0500.

Research was done keeping these variables -Independent variable: Dural tail sign in contrast enhanced MRI; Dependent variable: Radiological typing of DTS; Outcome variable: Histopathological grading of meningioma. Data collection sheet was used to collect the necessary information. Voluntary written informed consent was taken from the patients and/or the legal guardian/responsible family members after completely explaining to them the purpose of the study. Detailed history of illness was taken with general and neurological examination. The dural tail sign with it’s typing from contrast enhanced MRI of brain was noted. Postoperatively histopathological reports with grading were collected. The data collection sheet was designed by the researcher and approved by the faculty which contained all necessary information required for the study. The study was approved by the Institutional Review Board (IRB) or Ethics Committee, and all participants provided informed consent prior to their inclusion in the study.

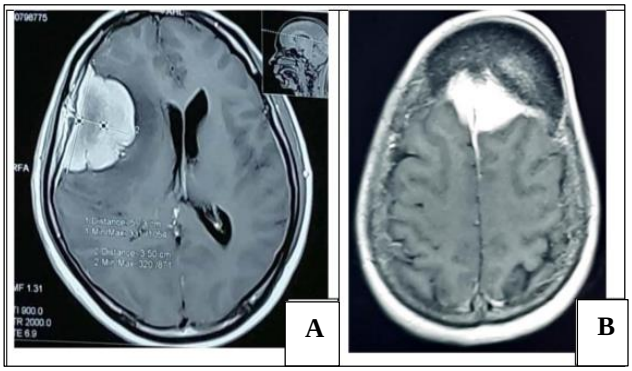

Figure 1 (A and B): Smooth type of dural tail commencing from base of the tumor, smoothly and uniformly extending to the end.

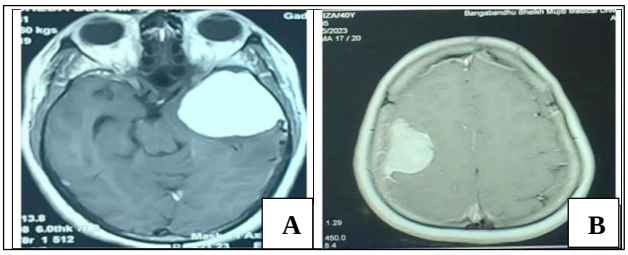

Figure 2 (A and B): Nodular type of dural tail appearing beaded with nodular hyperplasia.

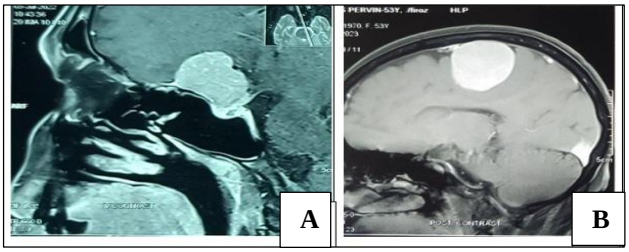

Figure 3 (A and B): Mixed type of dural tail commencing with the nodular enhancement and turning smooth as it extends.

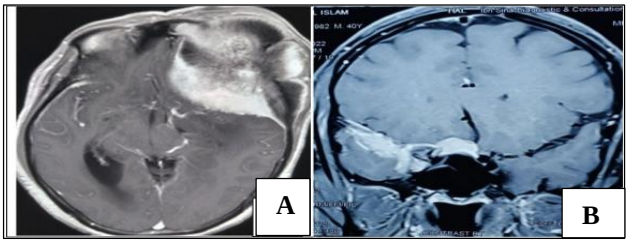

Figure 4 (A and B): Symmetrical multipolar type of dural tail with more than one tail displaying same pattern.

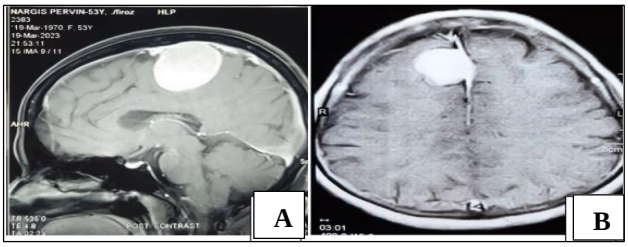

Figure 5 (A and B): Asymmetrical multipolar type of dural tail with more than one tail displaying different patterns of tail.

RESULTS

There were 22 individuals (62.9%) in the 28-47 age group and 13 individuals (37.1%) in the >47 age group. The mean age of the participants was 45.97 years±9.56. The median age was 45 years, ranging from 28 to 70 years. There were 9 male participants (25.7%) and 26 female participants (74.3%). The participants' occupations were categorized as follows: Housewife: 22 individuals (62.85%), Businessman: 3 individuals (8.57%), other service holder: 9 individuals (25.71%), Retired: 1 individual (2.85%). The mean duration of symptoms reported by the participants was 22.37±17.12 (months). The median duration of symptoms was 24 months, ranging from 3 to 84 months. 97.1% participants had headache, 54.3% patients had vomiting. 45.7% patients presented with visual disturbances, 25.7% patients had convulsion, 22.9% patients presented with weakness of limb and rest of the patients had clinical features like focal neurological deficit and autonomic disturbances (Table 1).

Table 1: Demographic and clinical characteristics of study participants with intracranial meningioma.

Characteristic		N	%
Age group in years	28-47	22	62.9
	>47	13	37.1
Gender	Male	9	25.7
	Female	26	74.3
Occupation	Housewife	22	62.9
	Businessman	3	8.6
	Other service holder	9	25.7
	Retired	1	2.9
Duration of symptoms	Mean (months)	22.37	
	Median (months)	24	
	Range (months)	3 - 84	
Clinical features	Headache	34	97.1
	Vomiting	19	54.3
	Visual disturbances	16	45.7
	Convulsion	9	25.7
	Weakness of limb	8	22.9

We found that parasagittal location (50%) and sphenoid wing (33.3%) were more prevalent in grade II. The other locations were all prevalent in grade I than Grade II mostly convexity (27.6%) and parasagittal (27.6%) (Table 2).

Table 2: Distribution of meningioma cases according to histopathological grade and tumor location.

Variable	Histopathological grade	
	Grade I (%)	Grade II (%)
Convexity	8 (27.6)	1 (16.7)
Parasagital	8 (27.6)	3 (50)
Sphenoid wing	2 (6.9)	2 (33.3)
Tuberculumsellae	2 (6.9)	0
Olfactory groove	2 (6.9)	0
Clinoidal	1 (3.4)	0
Others	6 (20.7)	0

The Table 3 describes the distribution of histological types according to grades. Choroid being the highest prevalent type (50%) in grade II followed by atypical (33.3%) and clear cell (16.7%). Among grade I, meningothelial was the most prevalent (48.3%) followed by transitional (34.5%).

Other types were distributed equally among grade I. The association was statistically significant (p<0.001).

Table 3: Distribution of meningioma cases according to histopathological grade and tumor subtype.

Variable	Histopathological grade		P value
	Grade I (%)	Grade II (%)	
Angiomatous	1 (3.4)	0	0.001
Atypical	0	2 (33.3)	
Choroid	0	3 (50)	
Clear cell	0	1 (16.7)	
Fibroblastic	1 (3.4)	0	
Fibrous	1 (3.4%)	0	
Meningothelial	14 (48.3)	0	
Psammoma-tous	1 (3.4)	0	
Secretory	1 (3.4)	0	
Transitional	10 (34.5)	0	

The Table 4 describes the significant distribution of the types of DTS among the histological grades of meningioma. The nodular cases (6,100%) were all grade II type. Mixed type was the most prevalent type among grade I.

Table 4: Distribution of meningioma cases according to tumor morphology and histopathological grade, with associated p values.

Variable	Histopathological grade		P value
	Grade I (%)	Grade II (%)	
Asymmetrical multipolar	7 (24.1)	0	0.001
Mixed type	16 (55.2)	0	
Nodular type	0	6 (100)	
Smooth type	4 (13.8)	0	
Symmetrical	1 (3.8)	0	
Symmetrical multipolar	2 (6.9)	0	

DISCUSSION

Aim of our study was to identify any association of radiological type of dural tail sign in contrast MRI with histopathological grading of intracranial meningiomas. We observed significant distribution of the types of DTS among the histological grades of meningioma. The nodular cases (6, 100%) were all grade II type. Mixed type was the most prevalent type among grade I. Qi et al studies of 179 patients showed such association previously.[10] They also found smooth-type DTSs were encountered in Grade I tumors, and the mixed DTS (52, 33.8%) was the most common type in these tumors. Nodular-type DTS was more commonly seen in non-Grade I tumors (12, 48%). The incidence of different types of DTS and their association with histopathological grading were statistically significant (p<0.001) in both studies. The incidence of meningiomas increases with age, mainly around the fifth decade of life.[3,11,12]

Baldi et al found the highest incidence observed between 30 and 59 years.[2] In our study of 35 sample, there were 22 individuals (62.9%) in the 28-47 age group and 13 individuals (37.1%) in the >47 age group.[2] The mean age of the participants was 45.97 years with a standard deviation of 9.56. The median age was 45 years, ranging from 28 to 70 years. Female incidence is about three-fold the male incidence in intracranial meningiomas.[2] Pieper et al. in his study found 36 (71%) females and 15 (29%) males in a total of 51 patients with a male-female ratio of 2.4:1, our study also replicate such thing.[13] We observed female predominance in our study where the male-female ratio was 1:3. This is because meningiomas' development is female-predominant.[2] Our study also proves female predominance as there were 9 male participants (25.7%) and 26 female participants (74.3%). As meningioma mostly a benign condition there is chronicity of symptoms usually. Studies have shown a linear growth rate of 2-4 mm/year for meningioma.[5] Our study also found such chronicity. The mean duration of symptoms reported by the participants was 22.37 months, with a standard deviation (SD) of 17.12. The median duration of symptoms was 24 months, ranging from 3 to 84 months.

Moradi et al in their study of 4885 patients with intracranial meningiomas, found that the most common clinical features were headache (66.7%), seizure (28.5%), and motor deficit (30%).[14] Similarly, Prabhu et al found that the most usual complaints were headaches (45.7%), seizures (25.7%), visual problems (20%) and limb weakness (8.5%).[15] Our study shows versatile distribution of the clinical presentation irrespective of the location of meningiomas. 97.1% participants had headache, 54.3% patients had vomiting. 45.7% patients presented with visual disturbances, 25.7% patients had convulsion, 22.9% patients presented with weakness of limb and rest of the patients had clinical features like focal neurological deficit and autonomic disturbances. Meningioma may occur anywhere that arachnoid cells are found (between brain and skull, within ventricles, and along spinal cord).[16,17] Studies of 336 cases found parasagittal as most common type of meningioma (20.8%) followed by convexity 58 meningioma (15.2%).[18] We also found that parasagital location (50%) as most prevalent. The other locations like sphenoid wing, tuberculum sellae were all prevalent in grade I and Grade II. We analyzed all cases radiologically, specially dural tail sign and categorized dural tail sign on five types according to size, shape and morphology. There were all five types of dural tail sign named asymmetrical multipolar, mixed type, nodular type, smooth type, symmetrical multipolar found in different proportion. We found mixed type (16, 55.2%) as the most prevalent followed by asymmetrical multipolar, where the nodular cases (6,100%) were all grade II type. Qi et al also found

mixed (57, 31.8%) as most common followed by asymmetrical multipolar (55, 30.7%).[10]

After surgery we studied the distribution of histological types according to grades. Choroid being the highest prevalent type (50%) in grade II followed by atypical (33.3%) and clear cell (16.7%). Among grade I, meningothelial was the most prevalent (48.3%) followed by transitional (34.5%). Other types were distributed equally among grade I. The association was statistically significant ($p<0.001$) association between radiological type of dural tail sign and histopathological grading our cases. So, the classification of the DTS can provide useful information for preoperative strategies, and it can aid in planning the extent of resection of tumour and involved dura, which could significantly reduce recurrence of meningiomas.

The study was conducted with a small sample size. So, the results may not represent the whole community, was the limitation of study.

CONCLUSION

As there is Association of radiological type of dural tail sign in contrast MRI with histopathological grading of intracranial meningiomas preoperative proper typing may help during counseling and surgical plan. We propose a classification of DTS based on radiological findings. We suggest collaboration of such recently completed or ongoing research, to obtain an overall view of intracranial meningiomas in our country.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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