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CORRELATION OF DURAL TAIL SIGN OF MENINGIOMAS ON MRI WITH HISTOPATHOLOGICAL GRADINGS

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ABSTRACT
Meningiomas are found to be most frequently slow-growing tumors, and presents with symptoms that are rarely precipitous, but more often subtle in nature. During physical examination it show paresis, memory impairment, other cranial nerve deficit, visual field deficit, paresthesia, aphasia, papilledema, low visual acuity, decreased level of consciousness, nystagmus and diminished hearing. Magnetic Resonance Imaging (MRI) of the brain in patient with intracranial meningiomas has been found to be useful in providing details about the diseases. Meningiomas arise from the arachnoid cap cells and are considered to be benign tumors in adults. The prevalence of dural tail sign in meningiomas ranges from 52 to 78%. The aim of this study was to predict an association between the dural tail sign in contrast T1 Weighted (T1WI) MRI with histopathological grading of intracranial meningiomas. The study population included 50 patients diagnosed as having intracranial meningiomas with or without dural tail sign in contrast T1WI MRI, who underwent surgery. Histopathological examination was considered gold standard for confirmation of meningioma. The association of dural tail sign was found to be insignificant with histopathological grading of intracranial meningiomas (WHO grade I & III) with P-value 1.000. The study also showed sensitivity, specificity and accuracy of dural tail sign in contrast MRI for the histopathological grading of intracranial meningiomas (WHO grade I and III) which were 53.2%, 33.3%, 48.0% and 66.7%, 46.8%, and 48.0%, respectively. Further, the present study, showed that dural tail sign was present in 54.0% and absent in 46.0% of the patients. The dural tail sign, which was seen in contrast T1WI MRI, was found insignificantly associated with histopathological grading of intracranial meningiomas. Therefore, the study concluded that the presence of the dural tail sign cannot predict the histopathological grading of intracranial meningiomas.

KEYWORDS: Meningiomas, Dural Tail sign, Magnetic resonance Imaging, association, Sensitivity, Specificity.

INTRODUCTION
Meningiomas are extra-axial primary neoplasms that arise from arachnoid cap cell in the outer layer of the central nervous system which may be intracranial or spinal. Meningiomas arise from the arachnoid cap cells and are considered to be benign tumors in adults. The prevalence of dural tail sign in meningiomas ranges from 52 to 78%.[1] In rare cases, the tumor may grow from fibroblasts of dura matter, arachnoid membrane around cranial nerve and vascular plexus.[2] Meningiomas are commonly found at the surface of the brain, either over the convexity or at the skull base. In rare cases, meningiomas occur in an intraventricular or intraosseous location. The clinical presentation of meningiomas is dependent on tumor location. Meningiomas are most often slow-growing tumors, and symptoms at presentation are rarely precipitous, but more often insidious in nature. Patient may present with history of headache, personality changes/confusion, paresis, paresthesia, generalized or focal seizures, visual impairment, diplopia, ataxia, aphasia, decreased level of consciousness, vertigo and decreased hearing. On physical findings show paresis, memory impairment, other cranial nerve deficit, visual field deficit, paresthesia, aphasia, papilledema, decreased visual acuity, altered level of consciousness, nystagmus and decreased hearing.[3]

Magnetic Resonance Imaging (MRI) of the brain in patient with intracranial meningiomas has been found to be useful in gaining insight about the diseases. Additionally, MRI has the advantages of being radiation free, excellent soft tissue imaging, multiplanar imaging, hence a lesion can be seen in multi-planes (sagittal, coronal and axial) which facilitates accurate localization of the lesion. It has better soft tissue characterization and can clearly demonstrate peritumoral edema, but its disadvantages are high cost, require more time, paucity of availability and contraindicated on a patient having metallic implants. MRI is the modality of choice for

investigation of meningiomas, providing superior contrast differentiation and usually the ability to differentiate between intra - and extra-axial lesion.[4] MRI provides excellent delineation of duramater and sinus involvement and even about a tumor's consistency.[5] Gadolinium is used as contrast material in MRI which aids in enhancement and delineation of tumor.

The accuracy of diagnosis of meningiomas on MRI is estimated to be about 95% in most series.[6] The typical MRI signal intensity characteristics consist of isointense to slight hypointense relative to grey matter on the T1-weighted sequence and isointense to slight hyperintense relative to grey matter on the T2-weighted sequence.[4]

On T_1 weighted MRI, about 60% of meningiomas are isointense and 30% mildly hypointense. On T_2 weighted images, the tumors are isointense (50%) or mildly to moderately hyperintense (40%). Hyperintensity on T_2 weighted images suggests higher water content.[7]

On T2 imaging, meningiomas have a more varied appearance, which seems to relate to the consistency of the tumor. Dense calcification may show up as darker areas, both on T_1 and T_2 weighted images.[5]

With the gadolinium DTPA infusion, meningiomas usually show a marked, homogeneous enhancement pattern, enhancement usually shows the tumor to be sharply demarcated from normal brain. A key feature is that they are usually based broadly on the dura. With infusion, meningiomas typically have a dural tail. The presence of such a tail, although suspicious, is not pathognomic for meningiomas. Enhancement usually results from tumor infiltration, but can also be because of non-neoplastic reactive change.[5]

There is a small amount of linear enhancement along the dura adjacent to the meningioma. A biopsy of this tissue may demonstrate either tumor or reactive granulation tissue but in either event this finding has both diagnostic and therapeutic significance. Its presence is highly characteristic of a meningioma and therefore diagnostic specificity is improved. Surgical excision of areas of dural enhancement may prevent marginal tumor recurrence. In approximately 10% of cases, small additional meningiomas are encountered that are missed on the unenhanced MRI.[8] Therefore, contrast MRI and Angiogram may be an adjunct in the preoperative assessment of some meningiomas. Angiogram enables the surgeon to assess the vascularity and vascular supply of the tumor, the feasibility of embolization and the presence of tumor encroachment on vascular structures.[7]

Preoperative estimates of vasculature, consistency and histopathologic features of meningiomas would be valuable aids in surgical planning, especially in cases in which tumor is located in the skull base or in which it encases cranial nerves or important blood vessels.[9] Thus, the aim of this study is to predict an association between the dural tail sign in contrast T1WI MRI with histopathological grading of intracranial meningiomas.

OBJECTIVES

1) To assess the dural tail sign in contrast T1WI MRI.
2) To find the association between dural tail sign and histopathological grading of intracranial meningiomas.
3) To estimate the sensitivity, specificity and accuracy of dural tail sign in relation to histopathological grading of meningiomas.

MATERIALS AND METHODS

An observational study consisting of 50 patients were included from January, 2016 to August, 2017 at the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, Shahbag, Dhaka.

The study population included all patients diagnosed as having intracranial meningiomas with or without dural tail sign in contrast T1WI MRI, underwent surgery in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, BSMMU. The exclusion criteria includes patient with histopathology report not consistent with meningioma, spinal meningiomas, recurrent/residual case of meningioma, patient refused to undergo surgery, and those unwilling to participate in this study. Histopathological examination was considered gold standard for confirmation of meningioma. Data collection sheet was used to collect the necessary information. Informed written consent was taken from individual patients and/or the legal guardian/responsible family members explaining to them the purpose of the study. At admission a detailed history of illness was taken and general and neurological examinations were carried out. Ethical clearance for the study was obtained from the Department of Neurosurgery and Institutional Review Board (I.R.B), Bangabandhu Sheikh Mujib Medical University.

Patient's data were collected in preformed questionnaire/data collection sheet. Every patient enjoyed every right to participate or refuse participation and had the right to withdraw from the study at any time. The common clinical presentations of the patients are presented in bar diagram 1. The neurological findings based on clinical examinations are presented as a bar Diagram in Figure 2. The privacy of the patient was strictly maintained and the patient's information would not be disclosed to any source. The study data was used for the purpose of this scientific study and would be helpful for both attending neurosurgeons and patient in making decision for management.

MRI Parameters

The MRI was carried with head coil system using brain coil at 3.0-T Philips Achieva (Philips Medical Systems) phased array receive head coil with an eight elements. A

saturation recovery gradient recalled sequence was used both for an initial T1 measurement and for the subsequent dynamic imaging. Each slice was acquired after application of a nonselective saturation pre-pulse with a saturation time delay (TD). Echoes were read with a radiofrequency flip angle of 30°. The parameters for T1WI (TR=382 ms, TE=1.9ms), matrix size=96x61 (interpolated to 256x256), FOV=240x182 mm^2, Slice thickness=5mm. The parameters for the T2WI includes (TR=4800 ms, TE=120). Gadolinium was used as contrast material for diagnosis of meningioma. 0.25 mmol/kg body weight was gadolinium was injected.

Statistical Analysis: Statistical analysis of the results was carried out using statistical package for social science (SPSS, Version 22.0). The frequency and percentage was calculated for age, gender and tumor distribution based on location and MRI findings. The pie chart was used to demonstrate the distribution of gender and bar diagram was used to present the clinical distribution and neurogical findings. The sensitivity, specificity and accuracy of dural tail sign in relation to histopathological grading of meningiomas were calculated. Fisher's exact test was used to calculate the association of dural tail sign with histopathological grading of intracranial Meningiomas. The 'P' value of <0.05 was considered as statistical significant.

RESULT

The mean age of all the patients was found to be 40.40 ± 14.24 years. The age range of the patients were 12-70 years and about (50.0%) of the patients belonged to 21-40 years age group. In this study 29 patients were female (58.0%) and 21 patients were male (42.0%). The male and female ratio was 1.00:1.38. Table 1 shows the distribution of patients according to tumor's location. Table 2 and 3 showed routine MRI findings (based on contrast and non contrast intensity) of the patients. Based on signal intensity on T1W1, hypointense was found in 19 (38.0%), isointense in 29 (58.0%) and hyperintense in 2 (4.0%). On T2W2, hypointense was found in 4 (8.0%), isointense in 27 (54.0%) and hyperintense in 19 (38.0%).

Dural tail sign in T1W1 contrast MRI was found in 27 (54.0%) of the patients, where as it was absent in 23 (46.0%) of the study patients. Further, the distribution of patients based on histopathological sub-types (n=50) are presented in Table 4.

According to histopathological gradings, 47 (94.0%) of were Meningioma WHO I and 3 (6.0%) were Meningioma WHO III. The association of Dural tail sign with histopathological grading of intracranial Meningiomas was carried out using Fisher's exact test, which was found to be insignificance (P>0.05) as shown in Table 5. Furthermore, association of Dural tail sign was carried out with histopathological grading WHO I (See Table 6) and WHO III (See Table 8) which showed insignificant result (Fisher's Exact test, P>0.05) . Tables 7 and 9 showed the sensitivity, specificity and accuracy of dural tail sign in contrast MRI for the histopathological grading of meningioma WHO-I and WHO-III.

Table 1: The table shows distribution of patients according to location of tumor (n=50).

Location of tumor	Frequency (n)	Percentage (%)
Parasagittal	9	18.0
Convexity	8	16.0
Sphenoid wing	8	16.0
Tuberculum sellae	4	8.0
Falcine	2	4.0
Planum sphenoidale	2	4.0
Spheno-orbital	2	4.0
Olfactory groove	1	2.0
Orbital roof	1	2.0
Lateral ventricular	1	2.0
Tentorial		
Tentorial base	4	8.0
Posterior Fossa		
Cerebellopontine angle	4	8.0
Petroclival	3	6.0
Petrous ridge	1	2.0
Total	**50**	**100.0**

Table 2: The table presents MRI findings on T1W1 and T2W2 imaging in all the cases (n=50).

MRI findings	Frequency (n)	Percentage (%)
T1WI		
Hypointense	19	38.0
Isointense	29	58.0
Hyperintense	02	4.0
T2WI		
Hypointense	04	8.0
Isointense	27	54.0
Hyperintense	19	38.0

Table 3: Distribution of study patients according to T1 contrast enhancement (n=50).

T1 contrast enhancement	Frequency (n)	Percentage (%)
Absent	01	2.0
Present	49	98.0
Mild	07	14.0
Moderate	09	18.0
Intense	33	66.0
Nature of enhancement		
Homogenous	23	46.0
Heterogenous	26	52.0

Table 4: Table shows the distribution of study patients according to sub-types (n=50) based on histopathology.

Sub-types	Frequency (n)	Percentage (%)
Meningothelial meningioma	34	68.0
Transitional meningioma	05	10.0
Fibroblastic meningioma	03	6.0
Psammomatous Meningioma	02	4.0
Anaplastic meningioma	02	4.0
Lymphoplasmocytc meningioma	01	2.0
Secretory meningioma	01	2.0
Microcystic meningioma	01	2.0
Papillary meningioma	01	2.0
Total	**50**	**100.0**

Table 5: Table shows association of Dural tail sign with histopathological grading of intracranial Meningiomas (n=50).

Histopathological gradings	Dural tail sign		Total	p value
	Present	Absent		
WHO-I	25 (92.6)	22 (95.7)	**47**	
WHO-III	02 (7.4)	01 (4.3)	**03**	P>0.05
Total	**27 (100.0)**	**23 (100.0)**	**50**	

Table 6: Association of Dural tail sign with histopathological grading of WHO I intracranial Meningiomas (n=50).

Dural tail sign	Meningioma WHO-I		Total	p value
	Positive	Negative		
Present	25 (53.2)	02 (66.7)	**27**	
Absent	22 (46.8)	01 (33.3)	**23**	1.000
Total	**47 (100.0)**	**03 (100.0)**	**50**	

The Fisher's exact test was done to measure the level of significance.
The p-value is **1.000**. The result is not significant at P<0.05

Table 7: Sensitivity, Specificity & Accuracyof dural tail sign in contrast MRI for the histopathological grading of meningioma (WHO-I) (n=50).

	Estimated Value (%)	95%CI	
		Min	Max
Sensitivity	53.2	51.2	56.6
Specificity	33.3	1.8	87.2
Accuracy	48.0	41.5	51.8

Table 8: Association of Dural tail sign with histopathological grading of WHO III intracranial Meningiomas (n=50).

Dural tail sign	Meningioma WHO-III		Total	p value
	Positive	Negative		
Present	02 (66.7)	25 (53.2)	**27**	
Absent	01 (33.3)	22 (46.8)	**03**	1.000
Total	**03 (100.0)**	**47 (100.0)**	**50**	

The Fisher exact test was done to measure the level of significance.
The p-value is **1.000**. The result is not significant at P<0.05

Table 9: Sensitivity, Specificity & Accuracy of dural tail sign in contrast MRI for the histopathological grading of meningioma (WHO-III) (n=50)

	Estimated Value (%)	95%CI	
		Min	Max
Sensitivity	66.7	12.8	98.2
Specificity	46.8	43.4	48.8
Accuracy	48.0	41.5	51.8

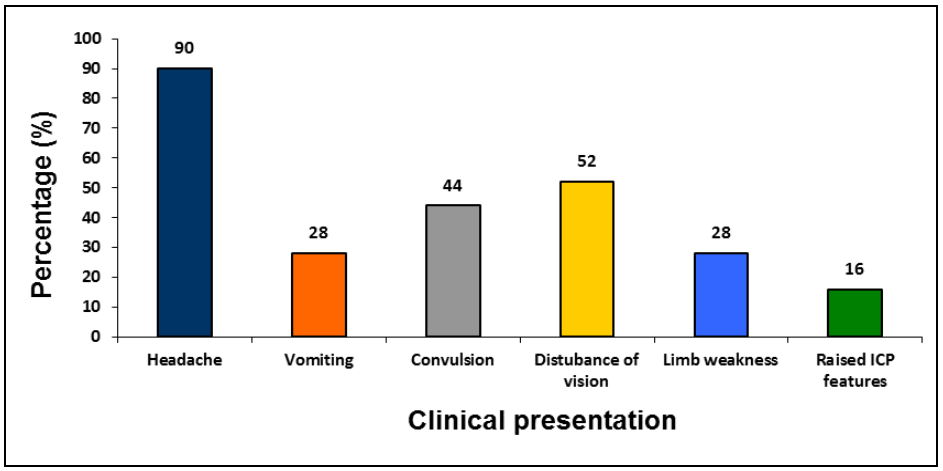

Figure 1: Bar diagram showing distribution of study patients according to clinical presentations (n=50).

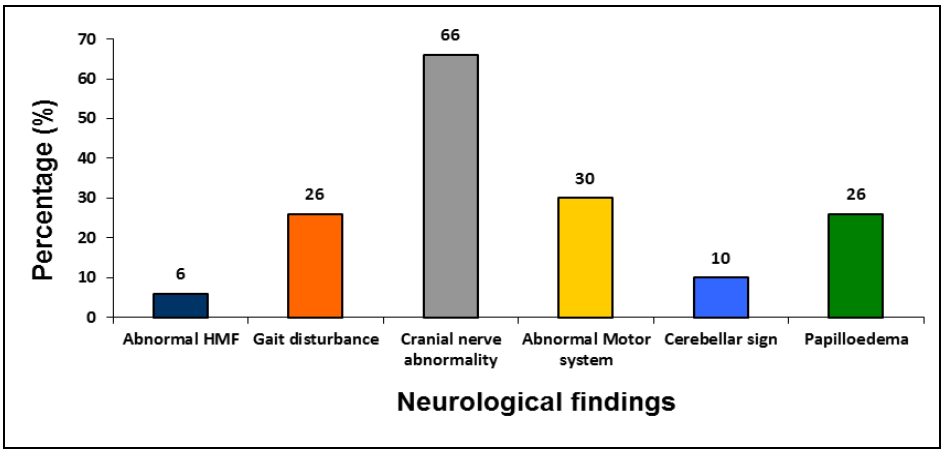

Figure 2: Bar diagram showing distribution of study patients according to neurological findings (n=50).

DISCUSSION

Meningioma are rare in children and young adults; they represent 1-3% of all intracranial tumors in individuals up to age 20 years and 13.5% of all intracranial tumors in the 20-34 age group; both significantly lower than the incidence in patients over the age 40.[10] Gangadhar et al. (2013) mentioned that the age distribution of meningioma revealed a maximum incidence in the fourth decade 30.43%, followed by sixth decade 17.89% and seventh decade 15.22%.[11] In this present study it was observed that (26.0%) patients were in fourth decade followed by third decade (24.0%) and fifth decade (20.0%) and the mean age was found 40.40±14.24 years with a range from 12 to 70 years. Similarly, Ibebuike (2014) found the mean age of patient with meningioma was 45.7 ± 10.5 years with age range 23-67 years.[12] Similar results were also presented by Moradi et al. (2008) where they found the mean age of patients with meningiomas was 49.11 ± 12.99 years with age range 6–78 years.[13] The higher age range may be due to geographical variations, racial, ethnic differences, genetic causes, and different lifestyle may have significant impacts to develop meningioma.

The incidence increases with ages, peaks after the fifth decade of life and affects female more commonly than male, having a 2:1 female:male ratio. The annual incidence per 100,000 people ranges from 2 to 7 for females and 1 to 5 for males.[14] Similarly, in this present study it was observed that meningiomas is predominant in a female subject, where 58.0% patients were female and 42.0% were male while female: male ratio was 1.38:1.0. Ibebuike et al. (2014) found 79.2 % were female and 20.8% were male with female: male ratio of 3.8:1.[12] Chernov et al. also (2011) found 78% were female and 22% were male with female:male ratio 3.5:1.[15] Similarly, Surov et al. (2016) found 77.5% were female and 22.5% were male with female:male ratio 3.4:1).[16] In another study Sitthinamsuwan et al. (2012) cited that the majority of the patients having meningioma were female 205 (84.4%) while 38 (15.6%) were male with a ratio of 5.4:1.[17] Similarly, female predominant was also observed by Moradi et al. (2008), Hoover et al. (2011) and Stefanovic et al. (2011) studies are also comparable to the current study indicating female compared to male.[13,18,19]

Moradi et al. (2008) mentioned that meningioma comes to clinical attention as a result of symptoms, including headache, seizure, hemiparesis or cranial neuropathy such as vision loss.[13] In this study, it was observed that 45 (90.0%) patients had headache followed by 26 (52.0%) had disturbance of vision, 14 (28.0%) had vomiting, 22 (44.0%) had convulsion, 14 (28.0%) had the weakness of limbs and 8 (16.0%) presented with features of raised ICP. However, Prabhu et al. (2014) found 45.7% headache, followed by seizure (25.7%) and vision change (20%) limb weakness (8.5%).[10] Moradi et al. (2008) found headache and vertigo 66.7% and epilepsy 28.5% in their study patients.[13]

Most meningiomas are supratentorial and only 8% to 10% are located in the posterior fossa. Convexity meningiomas were most common, followed by meningiomas of the sphenoid ridge and cerebellopontine angle.[13] In this study, distribution of meningioma by location showed parasagittal 18.0%, convexity 16.0%, sphenoid ridge 16.0%, tuberculum sellae 8.0%, tentorial base 8.0%, CP angle 8.0%, petroclival 6.0%, spheno-orbital 4.0%, planum sphenoidale 4.0 %, falcine 2.0%, olfactory groove 2.0%, ventricular 2.0% and orbital roof 2.0%, other 2.0%. Similarly, Watanabe et al. (2015) found convexity 23.2%, sphenoid ridge 18.6%, tuberculum sellae 16.2 %, clivus 11.6%, falcine 9.3%, CP angle 9.3%, parasagittal 6.9%, posterior fossa 2.3 % and tentorial 2.3 %.[20] However, Gangadhar et al. (2013) found that majority of the cases having meningioma involved parasagittal, CP angle, and sphenoid and petrous regions 15.27% each, followed by involvement of fronto-parietal 10.87%[11] as shown in Table 1.

Histopathological grading of intracranial meningiomas in this study was WHO-I (94.0%) and WHO-III (6.0%) with sub types were meningothelial 34 (68.0%), transitional 5 (10.0%) fibrous 3 (6.0%), psammomatous 2 (4.0%), anaplastic 2 (4.0%), lymphoplasmocytic 1 (2.0%), secretory 1 (2.0%), microcystic 1 (2.0%) and papillary 1 (2.0%). Similarly, Watanabe et al. (2015) found 96.4% WHO-I (meningothelial 60.4%, transitional 20.9 %, fibroblastic 9.3% and 2.3 % psammomatous and angiomatous each) and 4.6% WHO-II.[20] Similarly, Yogi et al. (2014) found 96.4% WHO-I (meningothelial 50%, 14.2 % transitional and angiomatous, 10.7% fibroblastic and 3.6% psammomatous and secretory) and 3.6% WHO-II.[21]

The association of dural tail sign was found to be insignificant with histopathological grading of intracranial meningiomas (WHO grade I & III) with P-value 1.000. The study also showed sensitivity, specificity and accuracy of dural tail sign in contrast MRI for the histopathological grading of intracranial meningiomas (WHO grade I and III) were 53.2%, 33.3%, 48.0% and 66.7%, 46.8%, and 48.0%, respectively. Further, the present study, showed that dural tail sign was present in 54.0% and absent in 46.0% of the patients.

The limitation of the study includes a small sample size. Randomization of the sample was not done, so there may be sampling bias. The study was based on inpatient patients in single center so the large scale multicenter study would aid more promising output that can be widely accepted in the clinical setting.

CONCLUSION

The dural tail sign, which was seen in contrast T1WI MRI, was found insignificantly associated with histopathological grading of intracranial meningiomas. Therefore, the presence of the dural tail sign cannot

predict the histopathological grading of intracranial meningiomas.

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