Original Research Paper

Volume-7 | Issue-9 | September-2017 | ISSN - 2249-555X | IF : 4.894 | IC Value : 79.96

Neurosurgery

VALUATING THE RADIOPATHOLOGIC CORRELATION OF COMMONLY OCCURING CNS TUMOURS

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ABSTRACT

AIM : To study the correlation between the Pathological nature and the radiological appearance of primary Central Nervous System neoplastic lesions based on the two most commonly used and easily available investigations namely CT Brain plain and contrast and MRI Brain plain and contrast.

MATERIALS AND METHOD : The study was conducted on all the patients admitted in the concerned admitting unit with a diagnosis of a central nervous system tumour between May 2013 to June 2015 at Thanjavur Medical College Hospital,Thanjavur. Total number of 243 patients were enrolled for the study.

CONCLUSSION : MRI had a higher or equal predictive value when compared to CT but statistically not significant. MRI had a higher predictive value for benign lesions than CT brain. Malignant lesions had more or less equal value for both CT and MRI low grade glioma is an important differential diagnosis for all the intrinsic tumours.

AIM OF THE STUDY : To study the correlation between the Pathological nature and the radiological appearance of primary Central Nervous System neoplastic lesions based on the two most commonly used and easily available investigations namely CT Brain plain and contrast and MRI Brain plain and contrast. To identify the specificity of CT Vs MRI in achieving the same. To assess the cost effectiveness of the imaging methods and find out which had better specificity.

KEYWORDS : .

INTRODUCTION

Neoplasms of the central nervous system are comparatively infrequent, though it is not as rare a condition as it was once assumed to be. From the very early days of very high mortality and morbidity rates, due to CNS tumours, substantial improvement in survival and outcome has been made because of the development of advanced, state of the art, imaging modalities which have made early diagnosis possible and improvement in neurosurgical equipments and techniques that allowed greater accessibility permitting a greater chance of gross total surgical resection and advanced radiation therapy to counter the rapid growth of the tumour. the advent of modern cross-sectional imaging techniques especially MR imaging have completely changed the method of assessment for follow up in affected patients Towards this goal, the spectrum of cross sectional imaging manifestations of commonly occuring primary central nervous system neoplasms like astrocytoma, meningioma, medulloblastoma, ependymoma and craniopharyngioma. A comprehensive summation of the correlation between the radiological appearances of these tumours and their pathological nature is studied.

STUDY MATERIALS AND METHODS

The study was conducted on all the patients admitted in the concerned admitting unit with a diagnosis of a central nervous system tumour between May 2013 to June 2015 at Thanjavur Medical College Hospital,Thanjavur. Total number of 243 patients were enrolled for the study.

Exclusion Criteria

1. Patients who died before surgery.
2. Patients admitted with recurrence.
3. Patients who were admitted with a proved pathological diagnosis at some other institute and later referred here.
4. Tumours which were not routinely biopsied at the institute like, brain- stem gliomas.
5. Patients who presented with haemorrhage at the tumour site were not included because of their distorted radiological appearance.
6. All the patients had CT Brain plain and contrast. Patients who had only plain MRI without contrast were included in the CT Brain group, their MRI was not taken into consideration for the study.
7. Patients who had multiple lesions were excluded from the study.
8. After admission patients who were diagnosed with a primary lesion elsewhere in the body were excluded from the study.

The above 191 patients were divided into two groups.

Group I - Only CT Brain plain and contrast.
Group II - CT Brain and MRI Brain plain and contrast.
Group I - Contained 191 patients
Group II - Contained 82 patients

Radiology criteria for the 6 types of tumours to be studied were formulated.

I. Low Grade Glioma: Intrinsic lesion.

CT **NECT**
- Ill defined homogenous hypodense or isodense mass.
-minimal or no surrounding oedema

CECT
-very minimal or no contrast enhancement.

MRI **TIWI**
- Homogenous hypointense mass
- Well circumscribed.
- Minimal or no surrounding edema.

T2WI
- Homogenous hyperintense mass.
- Circumscribed.
- Minimal or no surrounding oedema. FLAIR: Homogenous hyperintense mass T1 Contrast: no enhancement.

II. High Grade Glioma: Intrinsic Lesion

CT **NECT**
-Irregular ISO or hypodense mass
-necrosis (+)
-marked mass effect and surrounding edema.

CECT
-strong heterogenous, irregular ring enhancement.

MRI **T1WI**
-Irregular isointense to hypointense mass
-necrosis (+)
T2WI
-heterogenous, hyperintense mass.
-necrosis, cyst, fluid levels or flow voids may be seen.

FLAIR:heterogenous, hyperintense mass with surrounding

vasogenic edema.

T1C+: Thick irregular ring of enhancement surrounding areas of central necrosis - enhancement may be solid, ring, nodular or patchy.

III. EPENDYMOMA - midline posterior fossa lesion.
CT NECT
-4th Ventricle Tumour
-hypodense
-Calcification

CECT
-variable heterogenous enhancement.

MRI T_1WI
-heterogenous iso to hypointense
-cystic changes common

T_2WI
-heterogenous iso to hyperintense
-hyperintense cystic foci

T_1C+
-Variable enhancement

IV. MEDULLOBLASTOMA: midline posterior fossa lesion.
CT NECT
-Solid mass in midline vermian region
-hyperdense
-necrosis and cystic changes commonly seen

CECT
-patchy or homogenous enhancement.

MRI T_1WI
-hypointense to gray matter

T_2WI
-iso intense to gray matter
FLAIR-hyperintense to gray matter.
T_1C+-heterogenous enhancement.

V. CRANIOPHARYNGIOMA CT NECT
-mixed cystic and solid component iso to hypodense
-calcification common

CECT
-enhancement of nodule and rim

MRI
T_1WI
-iso to hyperintense cystic contents and solid component.

T_2WI
-hyperintense cysts
-hypointense calcification
FLAIR:hyperintense cyst contents.
T_1C:heterogenous enhancement of solid component, cyst wall enhance strongly.

VI. MENINGIOMA extrinsic lesion
CT NECT
-iso to hyperdense
-homogenous lesion
-hyperostotic or sclerotic bone changes.

CECT
-homogenous, strong, uniform enhancement.

MRI T_1WI
-iso to hypointense
-homogenous lesions

T_2WI
-iso to hyperintense
-homogenous lesion

T_1C: strong homogenous enhancement dural tail

Based on the above criteria the 191 patients were classified
Only tumours unambigously falling into any one of the above six types were selected and all other patients were excluded.
Finally

Group I had 153 patients
Group II had 67 patients
Group I had the following number of patients in each category.

Low Grade Glioma	-	27
High grade Glioma	-	47
Medulloblastoma	-	24
Ependymoma	-	7
Craniopharyngioma	-	17
Meningioma	-	31
Total	-	153

Group II had the following number of patients in each category.

Low Grade Glioma	-	15
High grade Glioma	-	17
Medulloblastoma	-	11
Ependymoma	-	2
Craniopharyngioma	-	7
Meningioma	-	15
Total	-	67

After surgery, the hispathological diagnosis of all the selected 153 patients were entered. Based on the above data a master chart was prepared. The correlation and measure of agreement were analysed statistically and the results are discussed in the following pages.

For Histopathological examination, light microscopy with routine eosin and haemotoxylin stains were used.

For the statistical analysis chi-square pearson formula was used.

RESULTS AND ANALYSIS

Table – 1
Table showing Correlation between MRI and Pathology.

MRI Diagnosis	Pathology						
	Low Grade Glioma	High Grade Glioma	Medullo blastoma	Ependymoma	Craniopharyngioma	Meningioma	Total
Low grade Glioma	15						15
High Grade Glioma	2	15					17
Medulloblastoma			10	1			11
Ependymoma				2			2
Craniopharyngioma					6		6
Meningioma						12	12
Total	17	15	10	3	6	12	63

Kappa (measure of agreement) = 94.0% ($p < 0.001$)

Table – 2
Table showing Correlation between MRI and Pathology (Including Other Diagnosis)

MRI Diagnosis	Pathology							
	Low Grade Glioma	High Grade Glioma	Medulloblastoma	Ependymoma	Craniopharyngioma	Meningioma	Others	Total
Low grade Glioma	15							15

High Grade Glioma	2	15						17
Medulloblastoma			10	1				11
Ependymoma				2				2
Craniopharyngio ma		1			6			7
Meningioma						12	3	15
Not available	16	27	12	3	9	13	6	86
Total	33	43	22	6	15	25	9	153

Table – 3
Correlation between CT and Pathology

CT Diagnosis	Pathology						
	Low Grade Glioma	High Grade Glioma	Medulloblastoma	Ependymoma	Craniopharyngioma	Meningioma	Total
Low grade Glioma	25						25
High Grade Glioma	3	41					44
Medulloblastoma	2		21	1			24
Ependymoma	1		1	5			7
Craniopharyngioma	1				15		16
Meningioma	1	1				25	27
Total	33	42	22	6	15	25	143

Kappa (Measure of Agreement) = 90.3% ($p < 0.001$)

Table – 4
Correlation between CT and Pathology (Including other Diagnosis)

CT Diagnosis	Pathology							
	Low Grade Glioma	High Grade Glioma	Medulloblastoma	Ependymoma	Craniopharyngioma	Meningioma	Others	Total
Low grade Glioma	25						2	27
High Grade Glioma	3	41					3	47
Medulloblastoma	2		21	1				24
Ependymoma	1		1	5				7
Craniopharyngiom a	1	1			15			17
Meningioma	1	1				25	4	31
Total	33	43	22	6	15	25	9	153

Table – 5
Low Grade Glioma CT Vs Pathology

CT Diagnosis	Pathology Confirmed	Agreement %
27	25	92.59%

Table – 6
Low Grade Glioma MRI Vs Pathology

MRI Diagnosis	Pathology Confirmed	Agreement %
15	15	100%

Table 7
Low Grade Glioma – Positive percentage

CT Diagnosis	MRI Diagnosis
92.59%	100%

Table – 8
High Grade Glioma CT Vs Pathology

CT Diagnosis	Pathology Confirmed	Agreement %
47	41	87.23%

Table – 9 High Grade Glioma MRI Vs Pathology

MRI Diagnosis	Pathology Confirmed	Agreement %
17	15	88.24%

Table – 10
High Grade Glioma - Positive Percentage

CT Diagnosis	MRI Diagnosis
87.23%	88.24%

Table – 11 Medulloblastoma CT Vs Pathology

CT Diagnosis	Pathology Confirmed	Agreement %
24	21	87.5%

Table – 12 Medulloblastoma MRI Vs Pathology

MRI Diagnosis	Pathology Confirmed	Agreement %
11	10	90.91%

Table – 13
Medulloblastoma – Positive Percentage

CT Diagnosis	MRI Diagnosis
87.5 %	90.94%

Table – 14 Ependymoma
CT Vs Pathology

CT Diagnosis	Pathology Confirmed	Agreement %
7	5	71.43%

Table – 15 Ependymoma MRI Vs Pathology

MRI Diagnosis	Pathology Confirmed	Agreement %
2	2	100%

Table – 16 Ependymoma - Positive Percentage

CT Diagnosis	MRI Diagnosis
71.43 %	100 %

Table – 17 Craniopharyngioma CT Vs Pathology

CT Diagnosis	Pathology Confirmed	Agreement %
17	15	88.24%

Table – 18
Craniopharyngioma MRI Vs Pathology

MRI Diagnosis	Pathology Confirmed	Agreement %
7	6	85.71%

Table – 19 Craniopharyngioma – Positive Percentage

CT Diagnosis	MRI Diagnosis
88.24 %	85.71%

Table – 20 Meningioma
CT Vs Pathology

CT Diagnosis	Pathology Confirmed	Agreement %
31	25	80.65%

Table – 21 Meningioma
MRI Vs Pathology

MRI Diagnosis	Pathology Confirmed	Agreement %
15	12	80%

Table – 22 Meningioma – Positive Percentage

CT Diagnosis	MRI Diagnosis
80.65%	80.00%

Table – 23
MRI Correlation for the Selected Tumours

MRI	Positive	Negative
Low Grade Glioma	100.00	0.00
High Grade Glioma	88.24	11.76
Medulloblastoma	90.91	9.09
Ependymoma	100.00	0.00
Craniopharyngioma	85.71	14.29
Meningioma	80.00	20.00

Table – 24
CT Correlation for the Selected Tumours

CT	Positive	Negative
Low Grade Glioma	92.59	7.41
High Grade Glioma	87.23	12.77
Medulloblastoma	87.50	12.50
Ependymoma	71.43	28.57
Craniopharyngioma	88.24	11.76
Meningioma	80.65	19.35

Table – 25 Correlating CT Diagnosis with MRI Diagnosis

CT Diagnosis	MRI Diagnosis							
	Low Grade Glioma	High Grade Glioma	Medulloblastoma	Ependymoma	Craniopharyngioma	Meningioma	Not Available	Total
Low grade Glioma	15						12	27
High Grade Glioma		16					31	47
Medulloblastoma			11				13	24
Ependymoma				2			5	7
Craniopharyngioma					7		10	17
Meningioma		1				15	15	31
Total	15	17	11	2	7	15	86	153

Significance of the difference in measures of agreement between CT and MRI

Table – 26
For Low Grade Glioma

CT	MRI
25	15
2	0
27	15

Not Significant

Table – 27
For High Grade Glioma

CT	MRI
41	15
6	2
47	17

Not Significant

Table – 28
For Medulloblastoma

CT	MRI
21	10
3	1
24	11

Not Significant

Table – 29 For Ependymoma

CT	MRI
5	2
2	0
7	2

Not Significant

Table – 30
For Craniopharyngioma

CT	MRI
15	6
2	1
17	7

Not Significant

Table – 31 For Meningioma

CT	MRI
25	12
6	3
31	15

Not Significant

Radiological Wrong Diagnosis
Table – 32
Wrong Radiological Diagnosis for Low grade glioma Group –1 - CT

Wrong Diagnosis	Case No.	Total
Haemangioblastoma	80 and 145	2
Total		2

Table – 33 Group – 2 - MRI

Wrong Diagnosis	Nil
Total	Nil

Table – 34
Wrong Radiological Diagnosis for High Grade Glioma Group – 1 - CT

Wrong Diagnosis	Case No.	Total
Low Grade Glioma	14, 52 and 151	3
Abscess	15	1
Secondaries	127	1
Tuberculoma	151	1
Total		6

Table – 35 Group – 2 - MRI

Wrong Diagnosis	Case No.	Total
Low Grade Glioma	14 and 52	2
Total		2

Table – 36
Wrong Radiological Diagnosis for Medulloblastoma Group – 1 - CT

Wrong Diagnosis	Case No.	Total
Low Grade Glioma	64 and 72	2
Ependymoma	89	1
Total		3

Table –37 Group – 2 - MRI

Wrong Diagnosis	Case No.	Total
Ependymoma	89	1
Total		1

Table –38
Wrong Radiological Diagnosis for Ependymoma Group – 1 - CT

Wrong Diagnosis	Case No.	Total
Low Grade Glioma	53	1
Medulloblastoma	60	1
Total		2

Table –39 Group – 2 - MRI

Wrong Diagnosis	Nil
Total	Nil

Table –40

Wrong Radiological Diagnosis for Craniopharyngioma Group - 1 - CT

Wrong Diagnosis	Case No.	Total
High Grade Glioma	21	1
Low Grade Glioma	123	1
Total		2

Table –41 Group – 2 - MRI

Wrong Diagnosis	Case No.	Total
High Grade Glioma	21	1
Total		1

Table – 42
Wrong Radiological Diagnosis for Meningioma Group – 1 - CT

Wrong Diagnosis	Case No.	Total
Tuberculoma	6 and 38	2
High Grade Glioma	7	1
Secondaries	18	1
Low Grade Glioma	30	1
Schwannoma	70	1
Total		6

Table – 43 Group – 2 - MRI

Wrong Diagnosis	Case No.	Total
Tuberculoma	6 and 38	2
Schwannoma	70	1
Total		3

Table 44
CT Diagnosis Malignant –Vs Benign

CT Diagnosis	Pathology				Total	
	Malignant		Benign			
	Count	%	Count	%	Count	%
Malignant	101	95.28	4	8.51	105	68.63
Benign	5	4.72	43	91.49	48	31.37
Total	106	100.00	47	100.00	153	100.00

Table 45
MRI Diagnosis Malignant –Vs Benign

MRI	Pathology				Total	
	Malignant		Benign			
	Count	%	Count	%	Count	%
Malignant	45	97.83			45	67.16
Benign	1	2.17	21	100.00	22	32.84
Total	46	100.00	21	100.00	67	100.00

Table 46
Positivity Agreement for Malignant Lesions CT Vs MRI

CT	MRI
95.28	97.83

Table 47
Positivity Agreement for Benign Lesions CT Vs MRI

CT	MRI
91.49	100

Table 48
Correlation between CT and MRI for the Group II Patients

CT	MRI	%
67	66	98.50

DISCUSSION

GROUP I PATIENTS - CT BRAIN

The pathological evaluation for the 153 patients were as follows:

Low Grade gliomas	-	33
High grade Gliomas	-	43
Medulloblastoma	-	22
Ependymoma	-	6
Craniopharyngioma	-	15
Meningioma	-	25
Others	-	9
Tuberculoma	-	3
Abscess	-	1
Secondaries	-	2
Schwannoma	-	1
Haemangioblastoma	-	2

GROUP II: PATIENTS - MRI BRAIN

The pathological evaluation for the 67 patients were as follows:

Low Grade gliomas	-	17
High grade Gliomas	-	16
Medulloblastoma	-	10
Ependymoma	-	3
Craniopharyngioma	-	6
Meningioma	-	12
Others	-	3
Tuberculoma	-	2
Schwannoma	-	1

Among group II patients, of the 15 patients with a radiological diagnosis of Low grade glioma, all the 15 has been reported as low grade glioma in histopathology study giving a measure of agreement of 100% for MRI (Table 6).

Among group I patients, of the 27 patients with a radiological low grade glioma diagnosis, 25 were low grade glioma on pathological examination, and the remaining two, were reported as haemangioblastomas. The measure of agreement was 92.59%, when compared with the 100% for MRI. The difference was not statistically significant (Table 25). The only radiological wrong diagnosis for low grade glioma among Group I patients was haemongioblastomas occurring in both patients, Cases No. 80, 145 (Table 32).

For the 47 patients in Group I with a radiological appearance of high grade glioma, 41 were reported as high grade glioma with a positive measure of 87.23% (Table 8). Among the different pathological diagnosis, three were low grade gliomas, (Cases No. 14, 52, 151), one was an abscess (case no. 15), one

secondaries brain (case no.- 127) and one was a tuberculoma (case no.151), having a common radiological wrong diagnosis of low grade glioma occuring 50% (Table 34).

As per table (9), a positive measure of 88.24 was found among Group II patients which was not significant when compared with group I patients (Table 26). Among the two radiological wrong diagnosis both were low grade gliomas cases 14 and 52 (Table 35).

So, low grade gliomas were the commonest radiological wrong diagnosis encountered in both group I and group II patients.

On evaluating the correlation for medulloblastoma, group one had 87.5% Table (11) agreement as against 90.9% for Group II patients Table (11). Among Group I, Low grade glioma was the common radiological wrong diagnosis with two out of three cases (Case No. 64 and 72), the other being an ependymoma (Case No. 89, Table 36). In group II, the only radiological wrong diagnosis was an ependymoma (Case No.89, Table 37) which occurred in Group I also. The agreement percentage between Group I and Group II patients was not significant statistically (Table 27).

The measure of agreement of Group I was 71.43% among the 7 patients (Table 14) as compared with 100% for Group II patients (Table 15) among ependymoma. But statistically considering, the difference was not significant (Table 28).

The two patients with radiological wrong diagnosis in the Group I were one low grade glioma-(Case No. 53) and one medulloblastoma-(Case No. 60, Table 38).

On considering craniopharyngioma there was a positive measure of 88.24% for Group I (Table 17) and 85.71% for Group II (Table 18) with the difference of agreement measure being not significant (Table 29).

The two radiological wrongly diagnosed lesions in Group I were one high grade astrocytoma (Case No. 21), and the other was a low grade glioma (Case No. 123 Table 40).

In group II the radiological wrongly diagnosed case was a high grade

astrocytoma Case No. 21 as in Group I (Table 41).

On evaluating Meningioma, the positive measure of Group I was 80.65 (Table 20) and for Group II it was 80.00 (Table 21).

In Group I, among the six radiologically wrong diagnosis for meningiomas there were two-tuberculomas, one - high grade glioma, one- secondaries brain, one - low grade glioma and a schwannoma, resulting in a wide spectrum of varied diagnosis when compared with all other tumors which had a very frequently occurring radiological wrong diganosis (Table 42).

In Group II, there were two tuberculomas and one schwannoma, the same cases that occurred in group I also (Table 43).

The measure of agreement between the two groups was not significant (Table 30).

Among the above results group II had higher correlation percentage when compared with Group I for all tumours except Craniopharyngioma and meningioma although the differences were marginal and not significant (Tables 22 and 23).

Overall group II had a kappa value of 94% ($p<0.001$) where kappa is a measure of agreement.

Group I had a kappa value of 90.3% ($p < 0.001$)

On considering meningioma and craniopharyngioma as benign lesions and the remaining four as malignant, the positive predictive value for Group II was 97.83 for malignant and 100% for Benign, slightly higher than that of Group I patients with 95.28 in malignancies and 91.49 for benign lesions. Considering these two groups statistically, it was not significant (Tables 44 and 45).

Among wrong diagnosis, Haemangioblastoma occurred in two patients when radiologically it was diagnosed as low grade gliomas and both cases on CT only.

The maximum radiological wrong diagnosis occurred in both High grade gliomas and meningioma patients among group I patients. Low grade gliomas occurring often in Group I and tuberculomas in Group II and all the frequent radiological wrong diagnosis occurred in Group II, with the same frequency as in group I.

Secondaries were reported in two cases one each in high grade glioma and Meningioma group among group I patients.

Among radiologically diagnosed meningiomas, tuberculoma occurred in two cases followed by schwannoma, secondaries, high grade glioma and low grade glioma once each. Interestingly both the tuberculomas were enplaque varieties, when both the radiological diagnosis were enplaque meningiomas.

Abscess and schwannoma occurred once each as pathological diagnosis when radiological diagnosis of the former was High grade glioma and the latter was meningioma. The latter especially belonging to Group II.

Low grade glioma occurred as pathological diagnosis for both radiologically diagnosed ependymona and medulloblastoma with no statistical significance.

Finally considering correlation among CT and MRI, the radiological diagnosis differed only once among 67 patients, (Case No.7) when MRI diagnosed High grade glioma and CT appearance resembled a meningioma. But, Pathologically it was a high grade glioma. The measure of agreement between CT and MRI as far as radiological diagnosis was concerned was 98.50, which showed not much of difference between the two common modes of investigations available, although CT has high affordability when compared with MRI.

CONCLUSION

In all groups MRI had a higher or equal predictive value when compared to CT but statistically not significant.

MRI had a higher predictive value for benign lesions than CT brain. Malignant lesions had more or less equal value for both CT and MRI. Haemangioblastomas occurred as a common pathological correct diagnosis for CT diagnosed low grade glioma cases whereas all MRI diagnosed low grade gliomas were pathologically correct. Hence in CT Brain suggestive of low grade glioma, Haemangioblastoma should be considered as a close differential diagnosis.

Low grade glioma was a common histological diagnosis for all the remaining tumours diagnosed radiologically as high grade glioma, medulloblastoma, ependymoma and Craniopharyngioma except meningioma in both Group I and II patients. So low grade glioma is an important differential diagnosis for all the intrinsic tumours.

Two enplaque meningiomas diagnosed radiologically, both were pathologically proved to be enplaque tuberculomas. Meningioma and high grade glioma were associated with higher number of radiological wrong diagnosis for a variety of lesions occurring in six cases each. So meningioma and high grade gliomas had the least measure of agreement in both the groups

The agreement value between CT and MRI is 98.5%. Although MRI had a higher kappa value than CT, the difference was marginal. When considering the cost, affordability and availability, though CT is slightly inferior to MRI, it is still comparable with MRI as far as pathological diagnostic aspect alone is considered.

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