



PREVALENCE OF PRIMARY INTRA-AXIAL BRAIN TUMORS ; A REGIONAL STUDY IN A POPULATION OF ESTERN PART OF INDIA--MRI EVALUATION WITH HISTOLOGY CORRELATION

Radiology

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ABSTRACT

Aim of study was to determine the diagnostic accuracy of magnetic resonance imaging (MRI) in preoperative diagnosis of primary intra-axial tumors and grading of gliomas compared with histopathology. It was a Prospective analytical study.

53 patients were included in the study who were provisionally diagnosed radiologically having intra-axial brain tumor or subsequently found to have pathologically proven primary intra-axial brain tumors.

RESULTS: The study included 53 patients with age ranging from 1-year 10-months to 70 years(mean 32.7 years). Twenty seven patients had supratentorial tumors (51%) and 26 had infratentorial tumors (49%). Twentyseven patients had Astrocytoma (51%), 10 had Oligodendroglioma(19%), 7 had Medulloblastoma (13%), 5 had Lymphoma (9%), and 4 had Hemangioblastoma(7%). Preoperative MRI diagnosis was correct in 50 patients with accuracy of 94%. No significant difference was found between preoperative MRI grading and postoperative histopathological grade of intra-axial tumor (p-value>0.05). Sensitivity, specificity, positive predictive value and negative predictive value of MRI in detecting tumor necrosis were 93%, 77%, 80% and 90% while for detecting tumor haemorrhage were 57%, 93%, 57%, and 93% respectively.

CONCLUSION: MRI is very accurate in preoperative diagnosis, staging and assessing the tumor characteristics of primary intra-axial brain tumors.

KEYWORDS

MRI- Magnetic resonance imaging, astrocytoma, GBM-Glioblastoma multiforme

INTRODUCTION

Cerebral tumors predominantly occur in adult life with a peak incidence of 13 cases per 100000 population at age of 55-65 year. They are relatively uncommon in infants and children at 2 cases per 100000 [1]. They can be classified as intra-axial and extra-axial[1]. Prompt diagnosis and treatment of cerebral neoplasms are critical to decrease both morbidity and mortality. CT and MRI are the mainstays of imaging in current practice. Since the introduction of Magnetic Resonance Imaging (MRI) in early 1980s, it has rapidly gained recognition as the optimal Investigational modality for intracranial neoplasm. [2]

Detection, localization & characterization of intracranial neoplasms by MRI are further achieved accurately by tumour contrast enhancement on CEMR (Contrast Enhanced Magnetic Resonance). Intravenous administration of paramagnetic contrast agent (Gadolinium chelate 0.1 mmol/kg body weight) causes shorting of both T₁ & T₂ relaxation time[4]

PATTERN ANALYSIS[3]

Basic Approach

- Where is the lesion ?
 - Supratentorial
 - Infratentorial
- Where is the lesion ?
 - Intraaxial
 - Extraaxial
- How old is the patient ?
 - Child
 - Adult

Most primary intra-axial brain tumors are malignant or potentially malignant. Most common of these include glial tumors, lymphoma, medulloblastoma and hemangioblastoma[5]

Data regarding the impact of MRI for diagnosis and staging brain tumor in our population is sparse, therefore, the purpose of this study is to determine the efficacy of MRI in preoperative diagnosis of primary intra-axial brain tumors and to determine its diagnostic accuracy in grading gliomas in our population, compared with histopathological findings taking as gold standard.

AIM OF STUDY

- To assess the distribution, features, localization and extent of intra-axial tumors by MRI.
- To correlate the tissue characterization by MRI with that of histopathological examination.
- To determine the diagnostic accuracy of magnetic resonance imaging (MRI) in preoperative diagnosis and grading of intra-axial gliomas compared with histopathology.

MATERIAL AND METHODS

SOURCE OF DATA: The study was conducted in the Department of Radiodiagnosis, Neurosurgery, Physiology & Pathology, SCB Medical College,

STUDY PERIOD: September 2013 to September 2015

STUDY DESIGN: Prospective analytical study.

110(65 male and 45 female) patients who underwent MRI brain examination with clinical suspicion of space occupying lesion, were included. All patients had different neurological symptoms; most common were headaches and seizures.

INCLUSION CRITERIA: were patients having intra-axial brain lesion and having MRI examination.

EXCLUSION CRITERIA: were contraindication to MRI, inappropriate medical/pathological records and follow-up patients. Out of 110 patients 57 patients were excluded from study. For 35 patients had extra-axial tumors, 11 patients had previous brain tumor surgery, they had come for follow-up, 2 patients had colloidal cyst on MRI, and 9 patients had known primary tumor came for MRI brain for evaluation of brain metastasis.

Fifty-three patients were finally selected for the study. In all patients surgery or biopsy was performed within two weeks of MR imaging. All the patients were examined with 1.5 Tesla systems. Brief history was obtained and any contraindication to MRI was assessed. A combination of T1 weighted, T2 weighted and FLAIR sequences and post gadolinium T1 weighted was obtained in all the patients.

Magnetic resonance imaging machine & technique:

All the MRI scans of the brain in this study were performed using GE Signa HDX MR machine with a 1.5 tesla field strength magnet.

Precontrast images were taken followed by intravenous administration of 0.1 mmol/kg of body weight of gadolinium. Consent of patient was

taken for injection of i.v. gadolinium. The standard imaging protocol used was

TABLE A: MRI PROTOCOL

Sequence	TR	TE	FOV Cm	Slice thickness mm	Inter slice gap mm	Imaging Matrix	No. Of excitation NEX
T2	5400	122.2	24 X 24	5	2.5	352 x 352	2
FLAIR	8002	87.7	24 x 24	5	2.5	256 x 224	2
T1	1806	17.2	24 x 18	5	2.5	320 x 192	2
DWI	4650	78.8	24 x 24	5	2.5	96 x 128	2
GRE	720	20	24 x 24	5	2.5	256 x 192	1
T1 SAG	480	11	24 x 24	5	2.5	320 x 160	1
T2 COR	5200	92	24 x 18	5	2.5	320 x 224	2
T1 AX CON	560	20	24 x 18	5	2.5	320 x 192	1
T1 SG CON	1906	9.7	24 x 24	5	1	320 x 192	2
T1 CR CON	580	20	24 x 18	5	2.5	320 x 192	1

The study was based on The “WHO classification of CNS tumors” which is the most widely accepted system for classifying CNS tumours from the 4th edition of ‘blue book’ ; year 2007. This classification was based on the histological characteristics of the tumor.

GRADING:

The St Anne-Mayo grading system is used to grade astrocytomas; which uses four morphologic criteria to assign a grade: 1- *nuclear atypia*, 2-*mitosis*, 3- *endothelial proliferation*, 4-*necrosis*.

The St. Anne-Mayo grade has four categories of tumors:

Grade 1 tumors do not meet any of the criteria (reserved for circumscribed astrocytomas such as pilocytic astrocytoma)

Grade 2 tumors meet one criterion, usually nuclear atypia (astrocytoma)

Grade 3 tumors meet two criteria, usually nuclear atypia and mitosis ("anaplastic" or "malignant astrocytoma)

Grade 4 tumors meet three or four of the criteria (glioblastoma multiforme)

MRI features of tumor in predicting grade included crossing mid line, edema, signal heterogeneity hemorrhage, border definition, cystic formation or necrosis and mass effect.

For preoperative diagnosis of intra-axial glioma criteria for grading as described by **Bruce et al** was used. MR imaging findings were evaluated for tumor crossing of midline, edema, tumor signal heterogeneity, hemorrhage, border definition, cyst formation or necrosis, and mass effect; each given a weighting of 0, 1 or 2.

Crossing Mid Line: Grade 0 indicate no crossing of midline; Grade 1 is for equivocal cases; Grade 2 indicate tumor has crossed mid line

Surrounding edema: Grade 0 indicate mild edema; Grade 1 is for moderate edema; Grade 2 indicate severe edema

Signal heterogeneity: Grade 0 indicate mild heterogeneity; Grade 1 is for moderate; Grade 2 indicate severe signal heterogeneity

Tumor hemorrhage: Grade 0 indicate no hemorrhage; Grade 1 is for equivocal cases; Grade 2 indicate definitive hemorrhage

Tumor border definition: Grade 0 indicate well circumscribed lesion; Grade 1 is for poorly circumscribed lesion; Grade 2 indicate highly infiltrating lesion

Cystic/ necrotic changes of tumor: Grade 0 indicate no cyst/ necrosis; Grade 1 is for equivocal cases; Grade 2 indicate definite cystic /necrotic changes

Mass effect of tumor: Grade 0 indicate mild mass effect; Grade 1 is for moderate; Grade 2 indicate severe mass effect adjacent to tumor

For low grade glioma including astrocytic glioma and oligodendroglioma the numbers are less than 3. For intermediate glioma including anaplastic astrocytoma and intermediate

oligodendroglioma the number ranges from 5 to 9. For glioblastoma multiformis the range is 10 to 14.

Location of tumor was also recorded. Diagnosis of all the patients was confirmed from biopsy reports, and pathological findings of surgical specimen. Preoperative MRI diagnosis and grading for intra-axial glioma were compared with postoperative pathological diagnosis and grading.

Statistical Analysis

Data were collected in predefined proforma, entered in Microsoft Excel, analysis was done in SPSS version 15. Pearson’s chi -square testing was done to see the statistical differences at 95% confidence level. P-value up to 0.005 were considered as significant. Sensitivity of MRI in staging of low, intermediate and high grade gliomas was calculated. Sensitivity, specificity, accuracy, positive predictive value and negative predictive value of MRI in characterizing the lesion for necrosis and hemorrhage were also calculated.

RESULTS

TABLE 1: AGE DISTRIBUTION

AGE GROUP(IN YRS)	NO OF CASES	PERCENTAGE
0-18	3	5.7
18-30	10	18.8
30-40	18	33.9
40-50	12	22.8
50-60	9	17
60-70	1	1.8

1. Most common age group 30-40 yrs

TABLE 2: DISTRIBUTION OF PATIENTS AS PER SEX

SEX	NO OF CASES	PERCENTAGE
MALE	35	66.04
FEMALE	18	33.96
TOTAL	53	100

2. Incidence in males came out to be more

TABLE 3: DISTRIBUTION OF SYMPTOMS

SYMPTOMS	No of CASES	PERCENTAGE
HEADACHE	19	36
VOMITING	13	24.5
HEAD REALING	3	5.6
HEMIPARESIS	6	11.3
Seizure	8	15.2
VERTIGO	2	3.7
LOSS OF CONSCIOUSNESS	2	3.7

3. Headache is the commonest symptom

TABLE 4 : DISTRIBUTION OF PATIENTS AS PER LOCATION

LOCATION	NO OF CASES	PERCENTAGE
SUPRATENTORIAL	27	50.9
INFRATENTORIAL	26	49.1
TOTAL	53	100

4. No significant difference in location between supra & infra tentorial

TABLE 5 :DISTRIBUTION OF PATIENTS AS PER TYPE OF BRAIN TUMORS

TYPE OF TUMOR	NO OF CASES	PERCENTAGE
GLIOBLASTOMA MULTIFORME	4	7.5
ANAPLASTIC ASTROCYTOMA	16	30.2
LOW DRADE ASTROCYTOMA	1	1.9
PILOCYTIC ASTROCYTOMA	6	11.3
OLIGODENDROGLIOMA	10	18.9
MEDULLOBLASTOMA	7	13.3
LYMPHOMA	5	9.4
HEMANGIOBLASTOMA	4	7.5

TABLE 6: PERCENTAGE OF NECROSIS/ CYSTS

TUMOR CHARACTERISTIC	GLIOBLASTOMA MULTIFORME	HIGH GRADE ASTROCYTOMA	LOW GRADE ASTROCYTOMA	OLIGODENDROGLIOMA	ANAPLASTIC OLIGODENDROGLIOMA
NECROSIS/CYSTS	100%	33%	0%	0%	100%

TABLE 7: PERCENTAGE OF HEMORRHAGE

TUMOR CHARACTERISTIC	GLIOBLASTOMA MULTIFORME	HIGH GRADE ASTROCYTOMA	LOW GRADE ASTROCYTOMA	OLIGODENDROGLIOMA	ANAPLASTIC OLIGODENDROGLIOMA
HEMORRHAGE(IN %)	67	16	0	0	50

TABLE 8: PERCENTAGE OF IRREGULAR MARGIN

TUMOR CHARACTERISTIC	GLIOBLASTOMA MULTIFORME	HIGH GRADE ASTROCYTOMA	LOW GRADE ASTROCYTOMA	OLIGODENDROGLIOMA	ANAPLASTIC OLIGODENDROGLIOMA
IRREGULAR MARGIN	100%	33%	0%	0%	100%

TABLE 9: PERCENTAGE OF MASS EFFECT

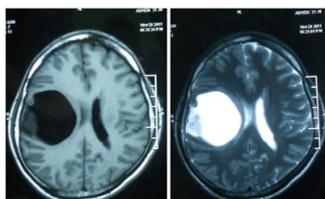
TUMOR CHARACTERISTIC	GLIOBLASTOMA MULTIFORME	HIGH GRADE ASTROCYTOMA	LOW GRADE ASTROCYTOMA	OLIGODENDROGLIOMA	ANAPLASTIC OLIGODENDROGLIOMA
MASS EFFECT (IN %)	100	100	67	50	100

TABLE 10: RANGE OF SCORE

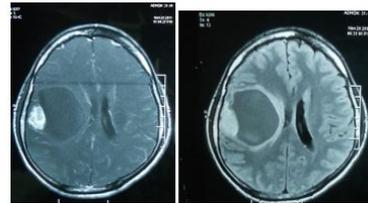
TUMOR	LOW GRADE ASTROCYTOMA	LOW GRADE OLIGODENDROGLIOMA	ANAPLASTIC ASTROCYTOMA	INTERMEDIATE GRADE OLIGODENDROGLIOMA	GLIOBLASTOMA MULTIFORME
SCORE	2-3	2-3	6-9	6-9	11-12

IMAGES

1. PILOCYTIC ASTROCYTOMA

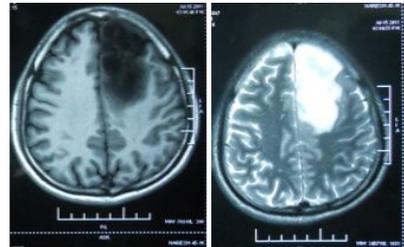


Left-T1W & right T2W image

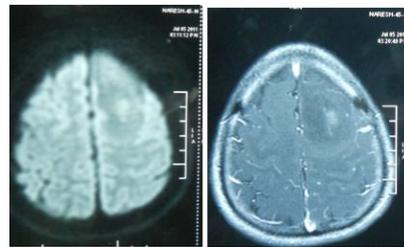


Post contrast T1W image
[1:31 yr male showing cerebral hemispheric cystic lesion with enhancing mural nodule. Biopsy- pilocytic astrocytoma]

2.GRADE II GLIOMA



Left-T1W & right T2W image

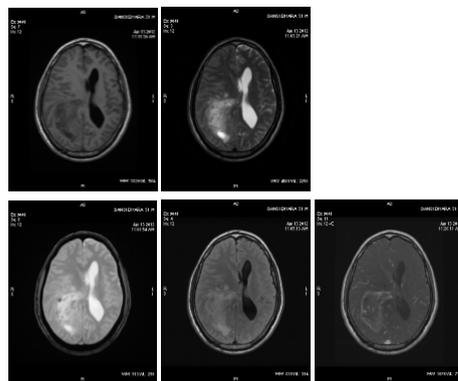


Left- Diffusion weighted image

& Right- Post contrast T1W image

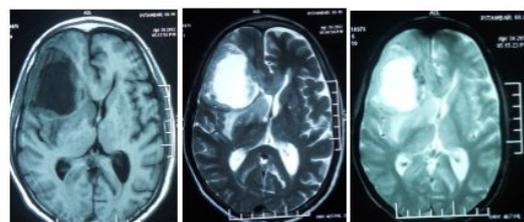
[45 Yr male complaining headache shows T1 hypo T2 hyperintense lesion in left frontal lobe. Small enhancing lesion in postcontrast image & no restricted diffusion rule out Acute Infarct.]

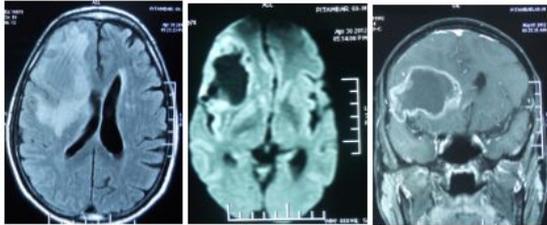
3.GRADE-III GLIOMA



[3:51 yr male showing a heterogeneously enhancing right parietal lesion which is crossing the corpus callosum with areas of hemorrhage seen in GRE image.]

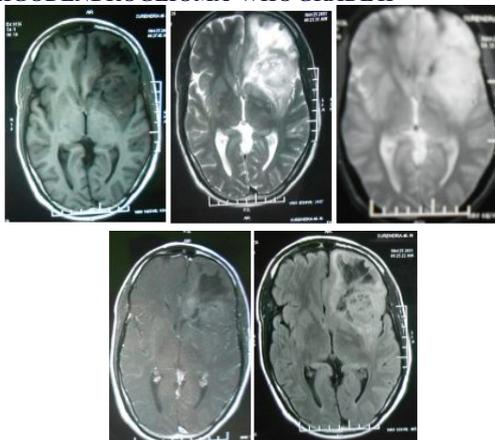
4.GLIOBLASTOMA MULTIFORME





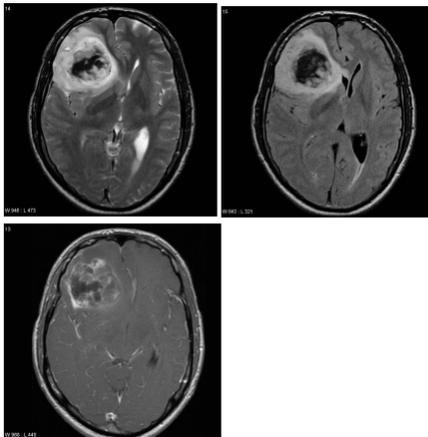
[4:60 yr male showing thick ,irregular & nodular ring enhancing right frontal lobe lesion, which shows hemorrhage/ neovascularisation in GRE , vasogenic edema in FLAIR and free diffusion on DW image. significant mass effect was noted.]

5.OLIGODENDROGLIOMA-WHO GRADE II



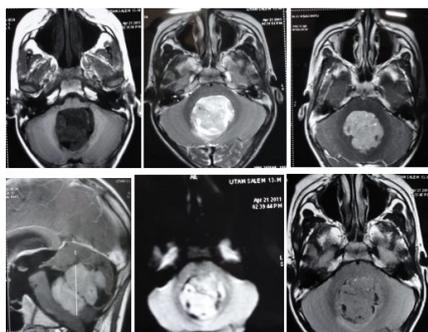
[5:46 yr male shows a heterogenous left frontal mass with enhancing areas and few foci of calcification on GRE sequence, Biopsy came out to be Oligodendrogloma – WHO grade II]

6.ANAPLASTIC OLIGODENDROGLIOMA



[6:Heterogenous, enhancing right frontal lobe mass on biopsy – Anaplastic Oligodendrogloma]

7.MEDULLOBLASTOMA



[7:13 yr male child showing an enhancing vermian mass which reveal restricted diffusion, biopsy- medulloblastoma]

DISCUSSION

Brain tumors are not uncommon in our set up. Although CT can show recognizable abnormalities, MRI is more sensitive for morphologic and tissue characterization because of better delineation of relationship of tumor to adjacent structures including vessels and detection of hemorrhage, necrosis, solid or cystic components within the tumor. This study was undertaken with the objectives of determining the distribution, morphology and tissue character of primary intra-axial tumors and to correlate the findings with histopathological examination.

110 (65 male and 45 female) patients who underwent MRI brain examination with clinical suspicion of space occupying lesion were included initially. Out of 110 patients 57 patients were excluded from study for several reasons. Fifty-three patients were finally selected for the study.

We, in our study of 53 patients of detected brain tumors, found that most of the patients were of 30-50 yrs. age group (56.6%), who suffered from brain tumors (Table-1).

Also in our study, male & female sufferer were 66.04% & 33.96% respectively (Table-2)

Common clinical manifestations are headache, vomiting, seizures, visual disturbances, personality change, vertigo and hemiparesis (Jacobs AH et al 2005).Commonest symptom came out to be headache in our study (table 3)

Twenty-seven tumors were supratentorial and 26 were infra-tentorial in location(table- 4)

In our study, 69.8 % of brain tumors in adults are gliomas (Table-5), indicating as the single largest group. Still this value is very high as we have excluded extra-axial tumors from our study group.In this present study 21 out of 53 patients had adult astrocytic series gliomas, 6 patients had pilocytic astrocytomas, 10 had oligodendro series gliomas, 7 had medulloblastomas, 5 had lymphoma and 4 had hemangioblastoma (Table-5)

Preoperative radiological diagnosis was correct in 50 cases (94% accuracy). No significant difference was found between preoperative MRI grading and postoperative histopathologic grade of intra-axial tumor.

Two false positive cases diagnosed as intermediate grade glioma, in which one turned out to be metastasis and other was lymphoma on histopathology. One false negative case preoperatively diagnosed as lymphoma proved to be anaplastic astrocytoma (Intermediate grade glioma) on histopathology.

All patients with glioblastoma multiforme (GBM), pilocytic astrocytoma, medulloblastoma and hemangioblastoma were correctly diagnosed by magnetic resonance imaging.

There were total 37 gliomas including astrocytic series and oligodendro series. Out of these 37 cases 27 were astrocytic gliomas and 10 were oligodendro gliomas. Out of 27 astrocytomas there were 6 pilocytic astrocytomas, 1 was low grade astrocytoma, 16 were anaplastic astrocytomas, and 4 were glioblastoma multiformis. Out of 10 oligodendro gliomas, 4 were low grade and 6 were intermediate grade gliomas.(table-5)

We found 5 low grade gliomas with score range of 2-3 including one low grade astrocytoma and 4 low grade oligodendro gliomas. None of the lesions were crossing mid line, 4 lesions had mild edema, all showed equivocal signal heterogeneity. None of the lesions had hemorrhage, 3 lesions had well defined margins and 2 had poorly defined margins, none of the lesions showed cystic or necrotic changes. Low grade astrocytoma had not showed mass effect but low grade oligodendro gliomas had moderate to severe mass effects (Table -5 to table- 10)

There were 22 intermediate gliomas with score range of 6-9, in which anaplastic astrocytomas were 16 and intermediate oligodendro gliomas

were 6. None of the anaplastic astrocytomas were crossing mid line, 2 intermediate oligodendrogliomas were also not crossing mid line but 4 did so. Eleven lesions were associated with moderate edema and 11 lesions had severe edema effect. Seventeen lesions were showing severe signal heterogeneity and 5 had equivocal signal heterogeneity. Only 5 lesions had hemorrhage. Only 1 anaplastic astrocytoma had infiltrative appearance and rest of 21 lesions had poorly defined margins. Only 1 lesion had well defined cystic/necrotic changes, 12 had equivocal changes and 9 lesions had showed no cystic/necrotic changes. All lesions had mass effect in which 10 had severe mass effect. (table -5 to table -10)

Out of 4 glioblastomamultiformis, score range was 11-12, 2 showed equivocal mid line crossing but two had definitive mid line crossing. Two lesions had mild edema and 2 had severe edema, all lesions showed severe signal heterogeneity. Two had equivocal hemorrhage and remaining 2 had definite hemorrhage, again 2 lesions had poorly defined margins and remaining 2 had infiltrative borders. All lesions had cystic or necrotic changes and severe mass effect. (table -5 to table -10)

Sensitivity, specificity, positive predictive value and negative predictive value of MRI in detecting tumor necrosis were 93%, 77%, 80% and 90% while for detecting tumor hemorrhage were 57%, 93%, 57%, and 93% respectively. The range of score for low grade astrocytoma was 2, low grade oligodendroglioma was 3, anaplastic astrocytomas was 6-9, intermediate grade oligodendroglioma was also 6-9 and glioblastoma multiformis had score range of 11-12. (table -10)

Pilocytic astrocytoma was in the range of 3-6, it means they have some low grade and intermediate grade score overlapping. (table-10)

In our series anaplastic Astrocytoma was the most common tumor (table-5), followed by Pilocytic Astrocytoma and GBM. This is in contrast to international literature, which describes GBM to be most common of astrocytomas (Burger PC et al 1982). Here the possibility of downgrading of astrocytoma due to technical difficulties while acquiring pathology specimen could not be ruled out. All the oligodendrogliomas were supratentorial. So Necrosis was seen in 100% of GBM and intermediate grade oligodendrogliomas. Cystic changes were seen in 33% of anaplastic astrocytomas. Irregular margins are seen in 100% of GBM, intermediate grade oligodendrogliomas and anaplastic astrocytomas. Mass effect was seen in all GBM, intermediate gliomas including oligodendroglioma and astrocytomas, but it is also seen in low grade oligodendroglioma. Hemorrhage is most commonly seen in GBM(67%) followed by intermediate grade oligodendrogliomas in 50% and anaplastic astrocytoma in 16%. Gross edema was seen most commonly with GBM (100%). Moderate edema is most common in intermediate grade oligodendrogliomas then anaplastic astrocytoma. So, tumor necrosis, irregular margins and peritumoral edema are most important markers for tumor grade. (table -5 to table -10).

Medulloblastoma is the most common primitive neuroectodermal tumor of CNS (Meyers SP et al 1992). In our series 5 tumors were located in fourth ventricle arising from cerebellar vermis and 2 tumors were eccentric arising from right cerebellar hemisphere.

Finally our study has some limitations; Sample size is small and prone for inter-observer variation.

SUMMARY

110 patients who underwent MRI brain examination with clinical suspicion of space occupying lesion, were evaluated judiciously, 57 patients were excluded from study for various reasons & Fifty-three patients were finally selected for the study.

Out of the 53 patients it was found that most of the patients (30 in no.) were of 30-50 yrs. age group (56.6%), And males occupied 66.04% & of the cases & females occupied 33.96%.

Twenty-seven tumors were supratentorial and 26 were infra-tentorial in location.

Preoperative radiological diagnosis was correct in 50 cases (94% accuracy).

No significant difference was found between preoperative MRI

grading and postoperative histopathologic grade of intra-axial tumor.

In our study, 69.8 % of brain tumors in adults are gliomas, indicating as the single largest group.

For low grade and high grade gliomas sensitivity of MRI was 100% while for intermediate grade gliomas sensitivity was 95%.

All patients with glioblastomamultiforme (GBM), pilocytic astrocytoma, medulloblastoma and hemangioblastoma were correctly diagnosed by magnetic resonance imaging.

In our series anaplastic Astrocytoma was the most common tumor, followed by Pilocytic Astrocytoma and GBM. This is in contrast to international literature, which describes GBM to be most common of astrocytomas.

Necrosis was seen in 100% of GBM and intermediate grade oligodendrogliomas. Irregular margins are seen in 100% of GBM, intermediate grade oligodendrogliomas and anaplastic astrocytomas. Mass effect was seen in all GBM, intermediate gliomas including oligodendroglioma and astrocytomas, but it is also seen in low grade oligodendroglioma. Hemorrhage was most commonly seen in GBM (67%) followed by intermediate grade oligodendrogliomas in 50% and anaplastic astrocytoma in 16%. Gross edema was seen most commonly with GBM (100%). Moderate edema is most common in intermediate grade oligodendrogliomas, then anaplastic astrocytoma.

So, tumor necrosis, irregular margins and peritumoral edema are most important markers for tumor grade.

CONCLUSION

MRI is accurate in preoperative diagnosis and assessing the characteristics of primary intra-axial brain tumors.

It is very accurate in assessing the grade of gliomas.

Tumor necrosis, irregular margins and peritumoral edema are most important indicators of tumor grade.

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