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CT evaluation of Brain tumours & its histopathological correlation

KEYWORDS: CT, Brain tumours, Diagnosis, Histopathology

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ABSTRACT *Aims: This prospective study was designed*
1 To study CT scan characteristics of various brain tumours.
2 To find out the incidence of these tumours in our study.
3 To evaluate the importance of cranial CT in the diagnosis of Brain tumours.
4 To correlate the CT findings of Brain tumours with Histopathological studies.
Material& Method: This prospective study comprises of total of 90 patients from both inpatient and outpatient departments in SMS Medical College, Jaipur & J.L.N. Hospital & R.C., Bhilai. All patients were investigated with CT in both plain and contrast enhanced studies, wherever necessary, reconstructed images were obtained. The provisional diagnosis made on the basis of CT features was correlated with the Histopathological study and final calculations were made.
Result: There was a good correlation between the CT diagnosis and the Histopathological report, thus proving the high sensitivity and predictability of CT. In the present study, the sensitivity of CT scan in the detection of brain tumours came out to be 96.67%.
Conclusion: Taking into consideration clinical presentation, age, sex and typical CT features, it is possible to predict the nature of an intracranial tumour with a high sensitivity and specificity.

Introduction:
Before the introduction of computed tomography, confirmation of the brain lesions was made by invasive diagnostic procedures which require hospitalization and carried some degree of risk, morbidity, and were time consuming.

The CT examination has helped the Brain tumour patients in early diagnosis, accurate localization and planning of the treatment. It is an excellent tool for the study of skull and intracranial contents, in which the tumour appears as altered tissue radiographic density. It helps in recognizing the type of the tumour by its characteristic appearance, accurate localization, tissue of origin, effect on the adjacent structures, and also in guiding and monitoring biopsies, selection and plan of appropriate treatment and periodic evaluation. Recent advances like 3D CT, colour coded CT and stereotactic guided biopsy have revolutionized the role of CT in the study of intracranial tumours.

The present study has been conducted in our institution to evaluate the data obtained from cranial CT in Brain tumours.

Material& Method:
The prospective study comprises of total of 90 patients from both inpatient and outpatient departments in Dr RML Institute of Medical Sciences, Lucknow. The study was conducted from July 2010 to June 2011 in the department of Neurosurgery& Radiodiagnosis.

CASE SELECTION:
Patients ranging from the age of 0-80 years who were clinically suspected to have intracranial space occupying lesion were investigated with CT in both plain and contrast enhanced studies.

Patients without an intracranial tumour on CT scan examination were excluded from the study, but the patients having intracranial tumour without a clinical suspicion were included in the study.

EQUIPMENT:
All the patients were studied on "GE HI-Speed Fx/i WIPRO Spiral CT scanner".

Matrix size – 512 x 512

Slice thickness – 7 mm in supratentorial fossa and 3-5 mm in posterior fossa

Gantry tilt – available upto 25^0 .

TECHNIQUE:
Patients were examined with CT scanner in the supine position with gantry tilt of 25 degrees, so as to parallel the scan plane to the orbito-meatal line.

Plain and contrast images were taken and analyzed for tumour location, size, number, margins, density, calcification, surrounding edema, mass effect, effect on ventricles, contrast enhancement. Bony involvement and attenuation values were obtained.

The follow-up and the management done for the patients were recorded with the final outcome. The diagnosis was confirmed by histology.

STATISTICAL ANALYSIS:
The sensitivity of CT scan for the detection of intracranial tumours was calculated using the formula :

Sensitivity = rue positive x 100

True positive + False negative

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Results:
The following observations were noted in the study:

S.No.	TYPE OF TUMOUR	HYPER	HYPO	ISO	MIXED	TOTAL CASES
1.	Low grade glioma (Gr 1 & 2)		8		1	9
2.	Anaplastic glioma (Gr 3)				5	5
3.	Glioblastoma multiformes	5			12	17
4.	Oligodendroglioma	2				2
5.	Ganglioglioma				1	1
6.	Ependymoma			3		3
7.	Medulloblastoma	3				3
8.	Craniopharyngioma	1			1	2
9.	Pituitary adenoma	3		2	1	6
10.	Meningioma	10		3	2	15
11.	Acoustic neuromas (Schwannoma/Neurilemmoma)		4	6		10
12.	Epidermoid cyst		3			3
13.	Colloid cyst		2			2
14.	Metastases	4	2	5		11
15.	Intracranial extension of regional tumours	1				1
	TOTAL	**29**	**19**	**19**	**23**	**90**

Table 1- Density relative to Brain parenchyma

S.No.	TYPE OF TUMOUR	HOMOGENOUS	HETEROGENOUS	PERIPHERAL	NODULAR	NON-ENHANCING	TOTAL NO. OF CASES
1.	Low grade glioma (Gr 1 & 2)	2				7	9
2.	Anaplastic glioma (Gr 3)			2	3		5
3.	Glioblastoma multiformes		16	1			17
4.	Oligodendroglioma					2	2
5.	Ganglioglioma	1					1
6.	Ependymoma	2	1				3
7.	Medulloblastoma	3					3
8.	Craniopharyngioma	1	1				2
9.	Pituitary adenoma	5				1	6
10.	Meningioma	11	4				15
11.	Acoustic neuromas (Schwannoma/Neurilemmoma)	6	2		2		10
12.	Epidermoid cyst					3	3
13.	Colloid cyst					2	2
14.	Metastases	7		4			11
15.	Intracranial extension of regional tumours	1					1
	TOTAL	**39**	**24**	**7**	**5**	**15**	**90**

Table 2- Enhancement pattern of Brain Tumours

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S.No.	TYPE OF TUMOUR	No. OF CASES	CALCIFICATION	EDEMA	BONE CHANGES	HYDROCEPHALUS
1.	Low grade glioma (Gr 1 & 2)	9	0	1	0	1
2.	Anaplastic glioma (Gr 3)	5	0	5	0	0
3.	Glioblastoma multiformes	17	0	17	0	5
4.	Oligodendroglioma	2	2	2	0	0
5.	Ganglioglioma	1	0	0	0	1
6.	Ependymoma	3	2	1	0	3
7.	Medulloblastoma	3	1	2	0	3
8.	Craniopharyngioma	2	2	2	2	1
9.	Pituitary adenoma	6	0	0	6	0
10.	Meningioma	15	2	11	7	7
11.	Acoustic neuromas (Schwannoma/Neurilemmoma)	10	0	8	7	2
12.	Epidermoid cyst	3	0	0	0	0
13.	Colloid cyst	2	1	0	0	2
14.	Metastases	11	1	6	5	0
15.	Intracranial extension of regional tumours	1	0	1	1	0
	TOTAL	**90**	**11**	**56**	**28**	**15**

Table 3- Incidence of calcification, edema, bone changes and hydrocephalus in Brain Tumours

Table 1,2 &3

1. Glioblastoma multiforme were predominantly of mixed density while meningiomas were predominantly hyperdense lesions.
2. Calcification was common feature in cases of oligodendroglioma and craniopharyngioma followed by ependymoma in our study.
3. Peritumoral edema was common feature in Gliomas, craniopharyngioma, intracranial extension of regional tumours, acoustic schwannoma, meningioma and metastases.
4. Almost all tumours were seen to enhance on contrast study except epidermoid & colloid cyst, oligodendroglioma and some cases of low grade glioma. Homogenous enhancement was commonly seen in pituitary adenomas, meningiomas and acoustic neuromas. Heterogenous enhancement was seen in Glioblastoma multiforme.
5. Significant bony changes were seen in the cases of pituitary adenoma, craniopharyngioma and intracranial extension of regional tumours followed by acoustic neuromas, meningiomas and metastases.
6. Hydrocephalus was common feature in the cases of Ganglioglioma, ependymoma, medulloblastoma and colloid cyst of 3rd ventricle in our study.

Discussion:

By virtue of this study, we attempted to evaluate the CT characteristics of various brain tumours and then compared with the previous studies. The CT findings in our cases were then correlated with the post operative histopathological report. Thus the sensitivity of CT scan for the detection of brain tumours was also calculated.

Relative incidences of various brain tumours in our study was compared and found to be similar with previous studies which have been discussed separately under each tumour.

GLIOMAS:

A total of 37 cases of Glioma were reported in our study including low grade astrocytoma, anaplastic astrocytoma, glioblastoma multiforme, oligodendroglioma, ganglioglioma and ependymoma, which accounts for an incidence of 41.1% of all Gliomas in our study.

These different subgroups will be discussed separately.

LOW GRADE GLIOMA:

In our study 8 out of 9 cases revealed non homogenous hypodense lesions involving mainly the white matter of the affected lobe while 1 tumour was of mixed density. According to Philippon JH et al and Butler AR et al, these tumours are hypodense in nature with mild edema & mass effect (14,4). Post contrast study revealed enhancement only in 2 cases (22.2%) which was mild in degree. Butler AR et al reported enhancement only in 15% of low grade gliomas (4). Peritumoral white matter edema was present only in 1 case. Ventricular dilatation on the contralateral side due to mass effect was seen only in 1 case. Calcification was seen in none of the cases.

Histopathology report showed typical features of Pilocytic, Fibrillary or Gemistocytic astrocytomas in all the cases which were of grade I in one case and of grade II in 8 cases.

ANAPLASTIC ASTROCYTOMA:

On plain CT scans, all five cases were ill defined heterogenous mass lesion of mixed density with moderate degree of peritumoral edema and mass effect which was similar with the findings of Tchang S et al in their study (19). Post contrast enhancement was seen in all the cases which were peripheral in two and nodular in 3 cases. Calcification was not seen in any of the case.

GLIOBLASTOMA MULTIFORME:

In all 17 cases, the tumour was ill- defined with irregular & thick borders. In most of the cases, the tumour infiltrates the adjacent lobes and in few it invades the corpus callosum and contralateral hemisphere and appears as butterfly. In 12 out of 17 cases the tumour mass showed heterogenous appearance with areas of cysts & necrosis with mixed density while rest 5 were hyperdense in nature. The peritumoral white matter edema with finger like projections into the gray matter was present in all the cases

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which was moderate to severe in grade. Amundsen et al reported peritumoral edema in 30 out of 31 Glioblastomas which was moderate to severe in 21 cases(1). Mass effect with mid line shift was present in all the cases. Ipsilateral compression and contralateral dilatation of lateral ventricles was present in 5 cases. Calcification was not seen in any case.

On post contrast CT scans, all the cases show moderate to marked enhancement which was heterogenous in 16 cases while 1 case show the peripheral enhancement which was similar to the findings of Amundsen et al (1) and Butler et al (1,4).

OLIGODENDROGLIOMAS:
Paxton & Ambrose and Vonofakos et al described these tumours as heterogenous mass having ill defined margins with foci of calcification and cystic degeneration (13, 20). Vonofakos et al reported 91% incidence of calcification in his study (20). In our study both the cases were hyperdense, non enhancing mass lesions with large & curvilinear calcification.

GANGLIOGLIOMA:
A single case of Ganglioglioma was reported in our study which was a 21 year old male who presented with convulsions.

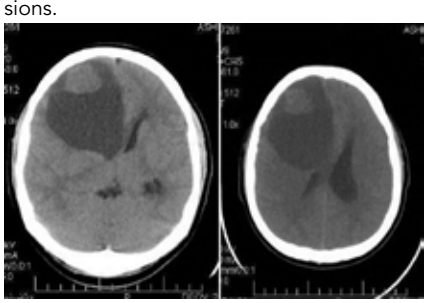

Figure 1: Well defined cystic mass lesion with enhancing mural nodule in the Rt. frontal lobe. CT Dx of Low grade Astrocytoma was made but Histopathology shows it to be Ganglioglioma.

In this case, our pre-operative diagnosis was considered as low grade astrocytoma because the lesion was well defined, eccentric intra-axial hyperdense mass which enhanced homogenously with cystic changes, hyperdense mural nodue and mass effect.**(Fig.1)** But the Histopathological

report showed it to be a ganglioglioma with ganglion type cells and psammoma bodies.

EPENDYMOMA:
In our study we reported three cases of ependymoma which represent 3.33% of total brain tumours.

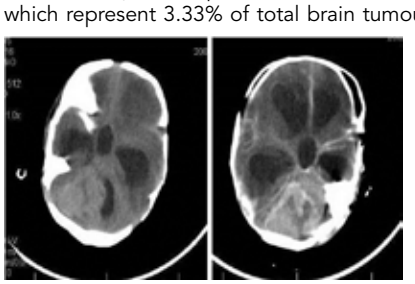

Figure 2: *Ill-defined, enhancing iso to hyperdense mass lesion in midline posterior fossa near 4th ventricle with severe hydrocephalus. CT Dx of Medulloblastoma was made but histopathology shows it to be Ependymoma.*

Two of the cases were reported preoperatively as ependymoma while the third case which was 1 year old male child presented as an isodense mass in right cerebellum compressing the 4th ventricle and showed heterogenous enhancement, was reported as medulloblastoma. **(Fig.2)** Histopathological report confirmed it to be ependymoma. All cases were isodense and shows enhancement which was homogenous in 2 cases and heterogenous in 1 case. Calcification was noted in 2 out of 3 cases (66.67%). Hydrocephalus was seen in all the 3 cases. According to Swartz JD et al, 73% of ependymomas are infratentorial within 4th ventricle.[7] He reported these tumours to be isodense in 80% cases on plain CT and about 80% shows enhancement. Approximately 50% cases exhibit calcification.

MEDULLOBLASTOMA:
In our study all the three cases show well defined hyperdense mass lesion in the posterior fossa which shows uniform homogenous enhancement on contrast administration. Hydrocephalus was seen in all the three cases. Zimmermann et al and Naidich TP et al reported these tumours as well defined, hyperdense (occasionally isodense) mass lesion showing homogenous enhancement and marked hydrocephalus which was similar to our study findings (23,11).

In our study two cases (66.67%) shows peritumoral edema and punctate calcification was noted only in 1 case (33.3%). Zimmermann et al, Naidich TP et al and Tadmor R et al reported peritumoral edema in majority of the medulloblastomas (23,11,18). Intratumoral calcification has been reported in 16% cases by Zimmermann et al and in 13% cases by Zee CS et al (18,21).

EPIDERMOID CYST:
In our study all the 3 cases showed well defined homogenously hypodense mass lesions of CSF density with lobulated margins located in the cerebellopontine angle on precontrast study. No enhancement was seen in either case on post-contrast study. No evidence of edema, calcification or ventricular dilatation was noted. Gao PY et al and Chaw TS et al in their study reported these tumours as well circumscribed hypodense mass lesions which do not enhance on post contrast study (8, 5). According to Osborn et al, these tumours are soft and do not cause hydrocephalus, mass effect or edema (12). All the findings in our study coincide with the previous studies.

COLLOID CYST:
Both the cases show well defined rounded hypodense mass lesion located within the 3rd ventricle obstructing the Foramen of Monro causing the obstructive hydrocephalus. Post-contrast enhancement was not seen in either of the cases. Calcification was noted in one case but edema was not seen in any of the 2 cases. Chaw TS et al reported in their study that on plain CT, these tumours presented as well delineated, rounded, hyperdense (72%) mass or isodense (22%) or a hypodense (6%) mass (5). They may or may not show any enhancement on post contrast study. The hydrocephalus due to blockage of Foramen of Monro is also seen.

CRANIOPHARYNGIOMA:
The tumours in both the cases were located in midline in the suprasellar region extending into the sella turcica caus-

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ing its widening and erosion. These tumours are commonly seen in children in suprasellar and sellar region. According to Maroldo TV et al expansion and/or erosion of sella turcica are common in these tumours (10).

The first case in our study presented with a well defined heterogenous mass lesion of mixed density with the areas of solid and cystic portions and showing heterogenous enhancement on contrast study, while the other case shows a well defined hyperdense mass lesion with homogenous enhancement. Both the cases show perilesional edema and calcification within the tumour. Hydrocephalus due to the 3rd ventricular compression was seen only in second case (50%). According to Maroldo TV et al, these tumours presented as heterogenous, partially calcified suprasellar mass with solid & cystic components showing post contrast enhancement and calcification in 90% of these tumours (10). Zimmermann RA reported in his study that these tumours may show hypodensity, hyperdensity, isodensity or mixed density depending upon the cyst formation (22). Keiffer and Lee in 1985 recorded 80% incidence of calcification in their study (9).

PITUITARY ADENOMA:
Four cases were located within the sella and the rest two were located in the suprasellar region. Banna et al in a review of 126 cases reported the bony changes like sellar enlargement and the erosion of dorsum sellae (3). In our study, these tumours were hyperdense in 3 cases, isodense in 2 cases, and of mixed density in 1 case. Five cases (83.3%) shows homogenous enhancement in post contrast study. No calcification could be detected in any of the tumour. No evidence of edema or hydrocephalus was noted in any of the cases. Banna et al reported similar findings with calcification in 4% of adenoms (3).

ACOUSTIC NEUROMA (SCHWANNOMA):
In the present series, 9 cases were reported preoperatively as Acoustic schwannoma while in one case, preoperative diagnosis of epidermoid cyst was made**(Fig.3)**.

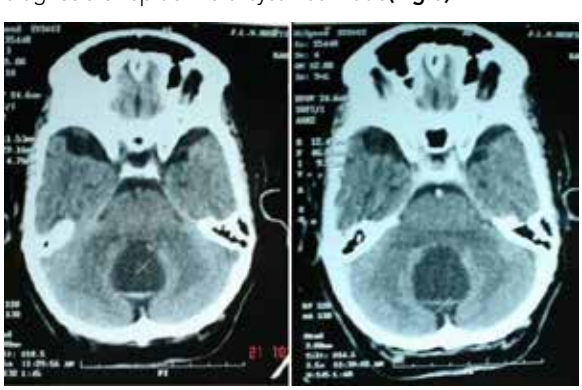

Figure 3: *Well defined rounded hypodense mass lesion with CSF-fluid level in midline posterior fossa. CT Dx of Epidermoid cyst was made but histopathology shows it to be Intramedullary Schwannoma.*

In that case who was 61 year old lady, the mass lesion was well defined, hypodense in nature located in the midline posterior fossa near the foramen magnum. Post contrast enhancement was very minimal and at the margins of the tumour. Fluid-fluid level was also noted within the tumour. Hydrocephalus and edema was not present in that case. All these findings were in the favour of epidermoid cyst but histopathological report showed it to be the case of intramedullary schwannoma. Hence it is included in this category.

In rest of the 9 cases, 6 cases were isodense and 3 were hypodense in nature. All the cases show post contrast enhancement. Enhancement was homogenous in 5 cases, and heterogenous & nodular in 2 cases each. Peritumoral edema was found in 8 out of total 10 cases (80%). Hydrocephalus was found in 2 cases (20%) but calcification was not seen in any case. All these findings coincide with the study of Paxton and Ambrose and Gado et al (17, 7). According to them, most of the acoustic neuromas were isodense and all showed enhancement, while Du Boulay et al observed some of these tumours to be hypodense merging into the surrounding cerebellar edema (6). 7 cases in our study show widening of internal auditory canal demonstrated on bony window setting.

Histopathological report showed the typical features of acoustic schwannoma in the 9 cases while in one case it turns out to be intramedullary schwannoma.

MENINGIOMA:
In our study most common location is parasagittal (4 cases), followed by convexity and cerebellopontine angle(3 cases each). 2 cases each were reported of falcine and tentorial origin, while one case is intraventricular in origin.

Out of total 15 cases, 10 were hyperdense, 3 were isodense and 2 were of mixed density. These tumours had well circumscribed, lobulated margins clearly demarcated from surrounding brain tissue. All the tumours show moderate to marked enhancement on contrast administration. 11 out of them show homogenous enhancement and 4 shows heterogenous enhancement. Amundsen has described meningioma as rounded or lobulated well-circumscribed hyperdense mass lesion.[4] Russel EJ et al reported 15% of the tumours to be of mixed density (16). 11 of our cases show peritumoral edema. Bony changes in the form of erosion or hyperostosis were noted in 7 cases (46.6%). Atlas SW reported calcification in 20% of the cases and vasogenic edema in 75% cases (2). Bony changes were common and better appreciated on CT.

METASTASES:
.In our study all the metastatic lesions were located at the grey-white matter junction either in cerebral or in cerebellar hemispheres which correlate with the study of Potts DG et al (15). Two cases showed multiple lesions and rest of the 9 cases show solitary lesion. Majority of them were well defined and rounded in shape. Site of primaries in our study were found to be as follows: Lung (4 cases), Breast & Neuroblastoma (2 cases each), Renal call CA, Hodgkin's Lymphoma & Leukemia (1 case each).

Out of total 11 cases, 5 were isodense, 4 were hyperdense and 2 were hypodense in attenuation on plain CT scans. All the cases showed moderate to marked post contrast enhancement (homogenous in 7 and peripheral in 4 cases). Moderate to extensive white matter edema was present in 6 cases. Bony involvement in the form of lytic lesion & erosion were seen in 5 cases (45.4%). Calcification was seen only in one case (9%) while hydrocephalus was not present in any case. According to Keiffer SA et al, contrast enhancement is virtually universal in these tumours (9).

INTRACRANIAL EXTENSION OF REGIONAL TUMOUR:
This case reported here was 35 year old female which was a known case of orbital tumour. On CT scan, this tumour appear as a solid hyperdense enhancing mass lesion in the

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right temporal lobe which is extending from the right orbit. There was evidence of peritumoral edema and erosion of sphenoid bone.

STATISTICAL ANALYSIS & CORRELATION OF THE CT DIAGNOSIS WITH HISTOPATHOLOGICAL REPORT:

In our present study, we have reported 90 cases of brain tumours in which the provisional CT diagnosis of 87 cases correlated well with the Histopathological report. In rest 3 cases CT diagnosis did not match with histopathology.

In one case we reported as a low grade astrocytoma but histologically it turns out to be Ganglioglioma. In another case we reported as medulloblastoma but histologically it showed to be ependymoma; and in the 3rd case, CT features were in the favour of epidermoid cyst while it turns out to be intramedullary schwannoma in Histopathological report.Thus the sensitivity of CT scan for the detection of intracranial tumours was calculated using the formula:

Sensitivity =True positive x 100
True positive + False negative
= 87 x 100
87+3
= 96.67 %

Thus the sensitivity of CT scan in the detection of intracranial tumours was 96.67% in our study. There was a good correlation between the CT diagnosis and the histopathological report, thus proving the high sensitivity and predictability of CT.

Conclusion:

All patients presenting with clinical suspicion of intracranial tumour should be thoroughly investigated according to the facility available. In developing countries, availability, economic feasibility, number of patients and maintenance cost are major deciding factors for choosing a diagnostic modality. Taking into consideration clinical presentation, age, sex and typical CT features, it is possible to predict the nature of an intracranial tumour. There was a good correlation between the CT diagnosis and the Histopathological report, thus proving the high sensitivity and predictability of CT in diagnosing intracranial tumours.

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