Diagnostic Accuracy of CT in Paediatric Intracranial Neoplastic Lesions – Radiologic and Pathologic Correlation

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Abstract

Background: The frequency of paediatric tumours in developing countries could be attributed to the increased percentage (39% of total population of children) in the overall population. Therefore, extensive researches should be under taken in the field of Paediatric Oncology in the third world.

Objective: This study was conducted to determine the diagnostic accuracy of CT by comparing the pre-operative radiological findings of paediatric brain tumours with post-operative histopathological findings on the basis of characteristic radiological features of various tumours.

Materials and Methods: This was a hospital based prospective, cross-sectional and descriptive study carried out in Radiology Dept, KEMU / Mayo Hospital, Lahore. Study was conducted over a period of 3 years from June 2005 till June 2008 and comprised of 100 cases of paediatric brain tumours up to 12 years of age. Cases were also collected from Mayo and Children Hospital, Lahore.

Results: Topographically, supratentorial tumours were found more than infratentorial 55 : 45. Low grade were more common than high grade 73 : 27. The most common tumour was astrocytoma with 52 cases. Medulloblastoma ranked the second with 16 cases followed by craniopharyngioma with 12 cases.

Conclusion: The diagnostic accuracy of CT scan was found to be 83% when correlated with histopathology. CT proved fairly accurate in detection of paediatric intracranial neoplastic lesions. As CT is relatively commonly available inexpensive modality than MRI so it can be used as non invasive imaging modality.

Key words: Paediatric brain tumour, Characteristic CT features, Diagnostic accuracy.

Introduction

Paediatric tumours arise in a brain that is in a process of growth and development. *There is a growing tumour in a growing brain.*[1] Tumours of the central nervous system (CNS) are the second most common solid tumours of childhood after Leukaemia. The incidence of Leukaemia is 37%, while CNS tumours are 22%.[2,3] CNS tumours are diverse, representing many biological types and arising in a variety of anatomic site.[2] The most common tumours include astrocytoma, medulloblastoma, primitive neuroectodermal tumours (PNET), ependymoma, brain stem gliomas, choroid plexus papilloma and carcinoma, gangliogliomas, pineal region tumours, optic apparatus and hypothalamic tumours, craniopharyngiomas, germ cell tumours (germinoma and teratoma).[4,5] Most of paediatric tumours of the central nervous system show characteristic radiologic findings, which can limit the differential diagnosis. Understanding of the relevant radiologic findings as well as the pathologic background and classification of these tumors is important for prompt medical attention and aggressive therapy for best prognosis.[6]

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Prior CT diagnosis allows prompt treatment to begin even before diagnostic confirmation by histopathological analysis. CT appearances can suggest a morphological diagnosis with higher degree of accuracy. If a diagnosis of a tumour could be made prior to the operation, the preoperative evaluation and operative plan could be tailored to the tumour.[6] The characteristic radiological features are based on density (hypo, iso to hyperdense), margins (whether well defined, poorly defined or ill distinct), anatomical location (whether supratentorial or infratentorial), and origin of the lesion (whether it is intra-axial or in the brain parenchyma in which lobe, whether it is extra-axial or within ventricular system), size and the extent of the tumour can be assessed. Midline shift, mass effect, oedema, herniation, presence of hydrocephalus, calcification, haemorrhage and necrosis were also seen. The degree of the enhancement is variable for various tumours in the post contrast scan. Some tumours show subtle enhancement, others show moderate or intense enhancement.[7-9] The pattern of enhancement may be homogenous or heterogeneous. Heterogeneity is due to necrotic areas in the tumour. Post contrast scan can also show solid and the cystic components in the mass. The degree of vasogenic oedema is clearly demarcated in contrast scans.[10-12]

Objectives

This study was conducted to determine the diagnostic accuracy of CT by comparing the pre-operative radiological findings of paediatric brain tumours with post-operative histo-pathological findings on the basis of characteristic radiological features of various tumours.

Materials and Methods

The study comprised of 100 children up to 12 years of age. Convenience, non probability, consecutive sampling was done. The study was conducted in Radiology Department, Mayo Hospital, Lahore. Cases were collected from Mayo Hospital, and Children Hospital, Lahore. Out of 100 cases, 49 children were from Mayo Hospital, and remaining 51 children were diagnosed at Children Hospital Lahore. The study continued over a period of 3 years from June 2005 till June 2008. All of these cases were diagnosed on CT Brain scan (plain and with IV contrast) in their respective hospitals. Among 100 cases studied, 94 (94%) patients received surgeries for tumours, and had histological diagnosis. For tumours without tissue proof, the diagnosis was made from relative specific clinical features, CT image findings, and locations of tumors and histopathological diagnosis of primary lesions. Sensitivity and specificity was calculated to determine diagnostic accuracy of CT.

Results

All 100 cases included in this study, were from 2 months to 12 years of age group with mean age at diagnosis was 6.8 years. Male to female ratio was 1.27: 1 with 56 boys and 44 girls. The diagnostic accuracy of CT scan was found to be 83% when correlated with histopathology. The CT sensitivity was 93% and specificity was 75%. Positive predictive value was 91% and negative predictive value was 0.8%. Topographically, supratentorial tumours were found more than infratentorial 55 : 45. Low grade tumours were more common than high grade 73 : 27. This corroborates the fact that the low grade tumours are more common in children of all age groups as compared to high grade tumours. The most common tumour was astrocytoma with 52 cases. Medulloblastoma ranked the second most common tumour with 16 cases, followed by craniopharyngiomas with 12 cases. Neuroanatomical location of the tumour of all 100 cases was tabulated. Cerebral hemisphere cases were 31 (31%), cerebellar hemispheres 30 cases (30%), sellar and suprasellar region 16 cases (16%), brain stem region 9 cases (9%), ventricular 8 cases (8%), thalamus 2 cases (2%), extraxial location 3 cases (3%) and pineal gland region 1 case (1%).

(i) Sensitivity = $a / (a + c) = 68 / 73 = 0.93$
93% of the patients are correctly identified as low grade in CT and Histopathology. Seven percent were incorrectly identified as low grade in both tests.

Table 1: Grading correlated to Radiological and Histopathological Diagnosis.

		Histopathology		Total
		Low Grade	High Grade	
CT	Low grade	68	7	75
	High grade	5	20	25
Total		73	27	100

(ii) Specificity = d / (b + d) = 7 / 27 = 0.25
It shows that 75% of the patients were correctly identified as low grade in both the tests and 25% correctly identified as high grades in both the tests.

CT/Histo Dx: Juvenile Pilocytic Astrocytoma

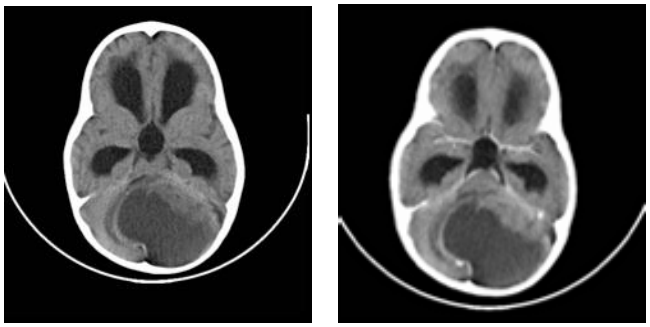

Fig. 1: Plain CT and with I/V Contrast.

CT/ Histo Dx: Choroid Plexus Papilloma

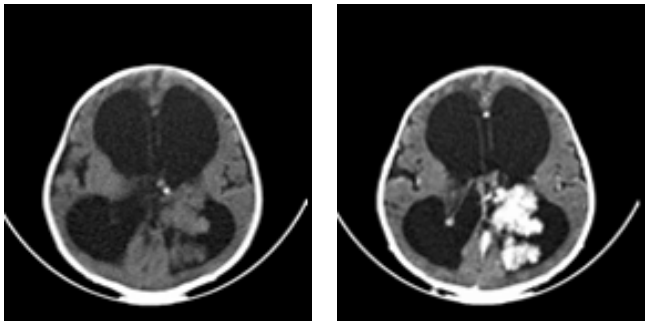

Fig. 2: Plain CT and with I/V Contrast.

CT Dx: Glioma Histo Dx: Oligodendroglioma

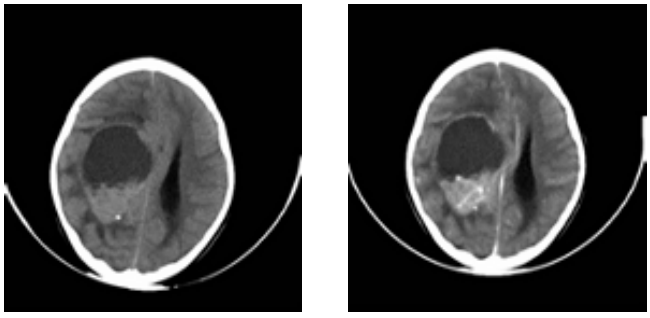

Fig. 3: Plain CT and with I/V Contrast.

(iii) Positive Predictive Value = a / (a + b) = 68/75 = 91%
91% is the probability of patients having low grade as the CT is identified as low grade.

(iv) Negative Predictive Value = d / (c + d) = 20/25 = 0.8
Since CT diagnosed 20 high grade, the probability of high grade is 0.8.

(v) False Positive Rate = b / (b + d) = 7/27 = 0.25
25% of the patients that histologically high grade have low grade in CT.

(vi) False Negative Rate = c / (c + d) = 5 / 25 = 0.2
Two percent of the patients that histopathologically low grade have high grade in CT.

CT/Histo Dx: Medulloblastoma

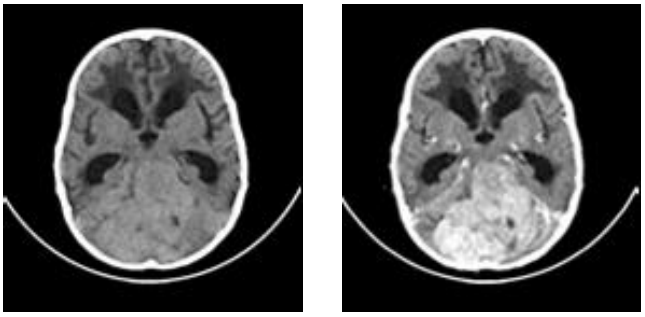

Fig. 4: Plain CT and with I/V Contrast.

CT/Histo Dx: Medulloblastoma

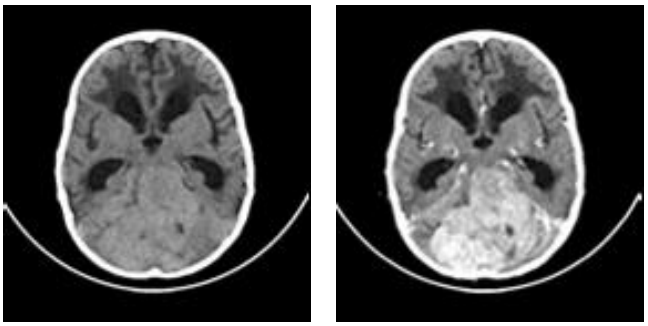

Fig. 5: Plain CT and with I/V Contrast.

CT Dx: Glioblastoma Multiforme

Histo Dx: Lymphoma

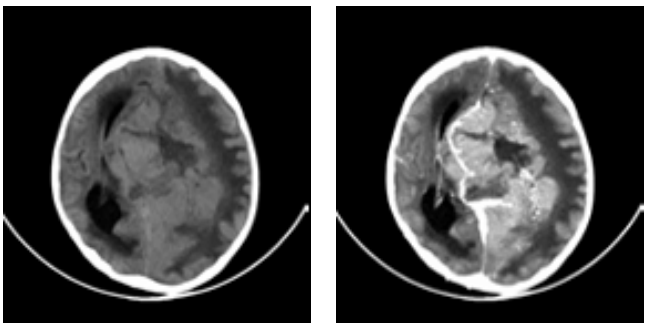

Fig. 6: Plain CT and with I/V Contrast.

Table 2: *Histopathology and Location of Tumour*.

Histological Diagnosis	Location of Tumour		Total	P-value
	Supratentorial	Infratentorial		
Juvenile Pilocytic Astrocytoma I	0	14	14	0.000
Astrocytoma G I	17	7	24	
Astrocytoma G II	9	2	11	
Astrocytoma G III	2	0	2	
Gliosarcoma G IV	1	0	1	
Oligodendroglioma	3	0	3	
Ependymoma	0	6	6	
DNET	1	0	1	
Medulloblastoma	0	16	16	
Craniopharyngioma	12	0	12	
Choroid Plexus Papilloma	1	0	1	
Teratoma	1	0	1	
Lymphoma	1	0	1	
Pineoblastoma	1	0	1	
Local Extension Retinoblastoma	4	0	4	
Metastatic	2	0	2	
Total	55	45	100	

Discussions

Out of 100 cases, 83 cases showed similarity in radiologic and histopathologic findings, while 17 cases showed variation. The CT and Histopathological diagnostic discrepancy was noted more in infratentorial region. 12 out of 17 cases (71%) were witnessed in infratentorial region, while 5(29%) in supratentorial region. This may be due to the limitation of CT imaging of posterior fossa lesions attributed to bone artifacts. Cerebellum had maximum variation of the diagnosis 11 out of 17 cases (65%), followed by 3 cases in cerebrum (18%), 2 in ventricular region (12%) and one case in sellar suprasellar region (5%).

This study was compared by five largest studies conducted on childhood intracranial neoplasms, two in America, one each in Germany, Korea, and Taiwan.[9,16-19] Stevenson's study in Atlanta narrated astrocytoma 52%, PNET / Medulloblastoma 21%, ependymoma 9%, craniopharyngiomas 7%, germ cell tumours 5%, choroid plexus papilloma 3%, rhabdoid 1% and others 2%. Duffner randomly reviewed the Central Brain Tumour Registry (CBTRUS) 1998 – 2002 and 2005 – 2006 and gave the similar results.[17] Kaatsch reviewed 3268 brain tumours in German children less than 15 years of period 1990 – 1999 and found astrocytoma 41.7%, medulloblastomas 18.1%, ependymoma 10.4%, supratentorial primitive neuroectodermal tumours 6.7%, craniopharyngiomas 4.4%.[18] One large study reviewed by Wong and associates in Taipei Taiwan from 1975 to 2004 including 968 children showed slight variable results.[19] The most common five categories of tumours were astrocytic tumours 31.1%, germ cell tumours 14%, medulloblastoma 13.3%, craniopharyngiomas 8.3% and ependymal tumors 5.8%. If we compare all results, incidence of astrocytoma stood the most common in all series with little variation in percentage. Medulloblastoma more or less ranked second most common. Topographic distribution of supratentorial and infratentorial region was also

compared. My study comprised 55 out of 100 were from supratentorial and 45 of infratentorial region. Stevenson and Sklar studies showed that in older children more frequent side is supratentorial and in young children had relatively high occurrence of tumour in infratentorial region. However the studies of Duffner, Kaatasch and Wong showed majority of childhood tumours occurred in supratentorial region.[16,18,19] In my study neuroanatomical distribution of the tumours tabulated and cerebrum was found commonest, followed by cerebellum and brainstem. Similar results were described in US studies of Stevenson, Duffner and Sklar. However in Kaatash and Wong studies cerebellar tumours were found slightly more common than in cerebrum. Neuroanatomical location of other tumours was found nearly similar to other studies.[18,19] So this study provided the comprehensive analysis of paediatric brain tumours with respect to epidemiology, CT and histopathological correlation and WHO tumour gradings. The data in all aspects was compatible with multiple international studies.

Conclusion

CT proved fairly accurate in detection of paediatric intracranial neoplastic lesions. As CT is relatively common available and quite inexpensive modality in our country than MRI, so CT with plain and IV contrast can be used as routine non invasive imaging modality.

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