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Role of computed tomography in the evaluation of pediatric brain tumor

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Abstract

A total of forty two clinically diagnosed pediatric brain tumors were studied over a period of two years. The study was aimed to evaluate the efficacy of computed tomography (CT) in pre-operative diagnosis of pediatric brain tumors by correlating the imaging findings with postoperative histopathological findings. Site, density, mass effect and contrast enhancement of the lesion were studied as primary efficacy variables of CT scan. In the present study, the common pediatric brain tumors were astrocytoma, medulloblastoma, craniopharyngioma and ependymoma. In 18(42.9%) cases the tumors were supratentorial and in 24 (57.1%), they were infratentorial in location. The findings of CT scan in different intracranial neoplasm strongly correlated with those of histopathology. The validity tests for CT scan were found to be 88.9% sensitive, 100% specific and about 95% accurate in diagnosing astrocytoma. Similarly the sensitivity, specificity, and accuracy for medulloblastoma were 100%, 96.9% and 97.7% respectively. For craniopharyngioma the values were 85.7%, 100% and 97.7% respectively. The study concludes that CT is an invaluable imaging modality in preoperative diagnosis of pediatric brain tumor due to its excellent characterization of tumors.

Introduction

Brain tumors are the most common neoplasms in children, next to leukemia[1]. Childhood cancer affects one in 600 children[2]. Most brain tumors occur sporadically and are of unknown cause; several including Teratoma and Craniopharyngioma result from congenital malformation. An increased incidence of certain intracranial neoplasm is seen in the neurocutaneous syndromes. Irradiation of the brain increases the incidence of cerebral sarcomas[1].

In about 80% of neoplasms in children the tumor type is glial cell tumor[3]. The remainder includes craniopharyngiomas, teratomas, hemangiomas, sarcomas and meningiomas. Among all the glial tumors, astrocytomas are the commonest comprising 44.8% of all the intracranial neoplasm. Medulloblastoma 15.5% ranks the second most common brain tumor followed by ependymoma 10.3%[3]. Incidence of various cerebral neoplasms and their location differ greatly from those observed in adults. Childhood neoplasms are more common in infratentorial location (56%) than supratentorial (44%)[3]. In infratentorial location, common tumors – Medulloblastoma (40%) and astrocytoma (31%) are of almost equal incidence. Brain stem gliomas are 20%, ependymoma of 4th ventricle is 11%[4].

In the supratentorial region- the common tumours are astrocytoma (25%), craniopharygioma (14%), suprasellar germinoma, and PNET (7%). Other less common are: choroid plexus papilloma, ganglioblastoma, non-Hodgkin`s lymphoma, pituitary adenoma, etc[5].

Metastatic lesion is rare in childhood and their incidence is 5 to 10%. The common pediatric solid tumors those metastasize the brain include neuroblastoma, musculoskeletal sarcomas, germ cell tumor and melanoma[6].

The clinical manifestations in childhood are largely those of increased intracranial pressure. Headache is common early symptom. Vomiting is projectile and unaccompanied by nausea. Drowsiness and stupor is late sign. BP is frequently elevated. Sixth nerve palsies are common with blurring of vision and diplopia, diminished visual acuity to blindness.

The plain radiograph is used in detection of intracranial neoplasm and searched for evidence of intracranial calcification and raised intracranial pressure signs. The signs include sutural diastases, sellar erosion, pineal gland displacement and increased convolutional markings. Confirmation of the presence or absence of brain tumor involved the use of diagnostic procedures such as cerebral angiographies or pneumoencephalography that requires hospitalization and carried a degree of morbidity and risk. However, normal skull radiograph does not rule out intracranial pathology and therefore further investigations with ultrasonography, computed tomography (CT) or magnetic resonance imaging is mandatory.

Ultrasonography (USG) can be performed in infants and young children before closure of fontanelle. Intracranial tumors are difficult to diagnose, particularly if the reflectivity is not too dissimilar to that of adjacent brain substances. Although not very specific for brain tumors, USG may guide the clinician to the appropriate subsequent imaging modality and may also be used to monitor the progress, treatment, and associated complications like-hydrocephalus, intracranial hemorrhage, calcification etc[7].

In computed tomography, accurate cross sectional anatomical details can be displayed without adjacent structures affecting the visualization of each other. CT can differentiate the density; hence air, fat, soft tissue calcification and bony involvement are readily discernible. Vascular structures can be further defined with the help of contrast. From the mid and the late 1970s, CT has emerged as the primary diagnostic screening modality for the detection of intracranial pathology[8]. In posterior fossa lesions, coronal images are often extremely helpful for evaluating the relationship of a tumor to the tentorium and the foramen magnum. Coronal images are also helpful in the evaluation of small lesions situated near dura or bone. Reformatted sagittal images may aid in evaluation of tumors of the midline structures such as the third ventricle.

MRI has its advantage of being a radiation free and multi planner imaging facility. Hence a lesion can be seen in three planes and accurate localization of the lesion can be done. This modality provides better soft tissue characterization and can clearly demonstrate peritumoral edema, but its disadvantages include its high cost and paucity of its availability. It also requires a long time for acquisition of the data and hence cannot be used for restless patient particularly neonates, infants or even uncooperative children. It can not be done in patients having metallic implants for which CT is the modality of choice[9].

CT is often more specific than MR imaging for preoperative tumor diagnosis. For example, small round cell tumors such as germinomas and medulloblastomas are isodense or hyperdense compared with brain parenchyma prior to administration of contrast agent, whereas astrocytomas of childhood are almost always hypodense. Thus, in general, suprasellar germinomas can be confidently differentiated from suprasellar astrocytomas with use of CT. Making this differentiation on the imaging study alone is often not possible with MR imaging. Similarly, the presence of calcification, which can be helpful in the preoperative diagnosis of craniopharyngiomas and teratomas, is less easily detected by MR imaging than by CT.

Newer multi-slice helical CT scanners are capable of providing highly collimated sub millimeter thickness sectional images in extremely short acquisition times and thus areas of hyperostosis or bone destruction, intratumoral calcification and early intratumoral or peritumoral hemorrhage are more completely defined with greater certainty on CT than on MRI[10].

Materials and Methods

This cross sectional study was carried out on consecutively selected 42 patients aged between 3 to 18 years, admitted into the Department of Neurosurgery of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, with the clinical history of brain tumor during the period from January, 2004 to December, 2005 and referred to the Dept. of Radiology and Imaging, BSMMU for CT scan of the brain with a suspicion of intra cranial neoplasm.

The following patients were included in the study:

- Patients having clinical suspicion of brain tumor.
- Patients aged 1 to 18 years irrespective of their sex.

The following patients were excluded from the study:

- Patients who were not willing to undergo surgery.
- Non-cooperative patient.

At first all the selected patients were evaluated through detailed history taking and clinical examination with special emphasis on the nervous system. Subsequently, CT scan of the brain was performed after counseling the patients or their parents. Proper sedation was applied in restless children. CT scan was done from caudal to cephalad level with 15 to 20 degree angulations to the canthomeatal line before and after the I.V contrast agent (Iopamidol- 370) administration with 5mm to 10 mm slice thickness. CT was performed at 120 Kv and 150 mA and was viewed in axial and if needed in coronal slices.

Those patients who were operated upon were continuously followed up after the surgery up to histopathological diagnosis. The histopathological reports were collected and were examined for correlation with the CT scan findings. All these information were collected in pre-designed structured data collection sheet and then organized using a scientific calculator and standard and appropriate statistical formulae. Further statistical analyses of the results were obtained by using computer software Statistical Packages for Social Sciences (SPSS). Statistical tests for significance of difference were done using `Z` test where applicable. The validity tests such as sensitivity, specificity and accuracy were determined by standard statistical formulae.

Results

The age range of the patients was 3 to 18 years. The mean age ± SE was 10.6 ± .56 years and the peak incidence was found in the age group between 10 to 12 years. Out of this 28 (66%) were male and 14 (34%) were female. Male female ratio was 2:1. The main presenting complaints were headache in 40 (95.4%), vomiting 30 (71.4%), vertigo 17 (40.28%) cases. Others were blurring of vision, convulsion and weakness of limb. Among the 42 patients in this study, in 18 (42.9%) cases the tumors were supratentorial and the rest were infratentorial in location. The most common tumors were astrocytoma (38%), medulloblastoma (26%), craniopharyngioma (14%), and ependymoma (7%). CT scan findings were compared (Table-1) with histopathological findings. Eleven cases were diagnosed as medulloblastoma. 70% of medulloblastoma were hyperdense, 30% were isodense. Hydrocephalus was seen in all cases of medulloblastoma. Contrast enhancement was present in 90% cases. Craniopharyngioma was diagnosed in 6 cases where the tumors were hypodense in 87% and isodense in 13% cases. Calcification was present in 87.5% cases and contrast enhancement was seen in 100% cases. For asrtrocytoma, the validity tests showed the sensitivity of CT was 88.9%, the specificity was 100%, the accuracy was 95.2%, the positive predictive value was 100% and the negative predictive value was 92.3%. The sensitivity for medulloblastoma was 100%, the specificity was 96.9%, the accuracy was 97.7%, the positive predictive value was 90.9% and the negative predictive value was 100%. For craniopharyngioma, the sensitivity was 85.7%, the specificity was 100%, the accuracy was 97.7%, the positive predictive value was 100% and the negative predictive value was 97%.

Table 1: Comparison between CT and histopathological findings of pediatric brain tumors:

Findings	CT	Histopathology
Astrocytoma	16 (38.1)	18 (40.5)
Medulloblastoma	11 (26.2)	10 (23.8)
Craniopharyngioma	6 (14.3)	7 (16.7)
Ependymoma	3 (7.1)	3 (7.1)
Brainstem glioma	2 (4.8)	2 (4.8)
Germinoma	2 (4.8)	2 (4.8)
Pituitary adenoma	1 (2.38)	0
Arachnoid cyst	1 (2.38)	0

Figures in parentheses indicate percentages

Discussion

This cross sectional study was done to evaluate the diagnostic accuracy to computed tomography of paediatric brain tumor with respect to histopathological findings. The component of accuracy tests are sensitivity, specificity, positive and negative predictive value. As regards to the location of the paediatric brain tumors, the incidence of supratentorial and infratentorial tumors in the present study closely agree with others[3].

The most common brain tumor in this study was found astrocytoma, followed by medulloblastoma, craniopharyngioma and ependymoma. These findings were close to study of other investigators[1]. Among the cases in supratentorial location, most common pediatric brain tumors were astrocytoma and craniopharyngioma[5]. Twenty-four cases were in infratentorial location, the common tumors were medulloblastoma, astrocytoma, ependymoma. These findings were close to the study done by others[4].

Eighteen cases were confirmed as astrocytoma by histological examination, among them 16 cases were diagnosed as astrocytoma in CT. Other two cases were diagnosed as medulloblastoma and arachnoid cyst by CT. In NECT the tumors were hypodense in 53%, isodense in 17.6 %, mixed density in 23% and hyperdense in 5.9% cases. Calcification was present in 17.6% cases. These findings were almost similar to others[4]. Contrast enhancement were noted in 94% cases in this study and which was supported by others[11,12]. Eleven cases were diagnosed as medulloblastoma. However, 10 cases were proved medulloblastoma by histopathology. One case was diagnosed as astrocytoma by histopathology. In NCCT 70% of medulloblastoma were hyperdense, 30% were isodense. Hydrocephalus was seen in all cases. Contrast enhancement was present in 90% cases. These findings were almost similar to other investigator[13]. CT correctly diagnosed craniopharyngioma in 6 cases out of 7 cases. The other case was diagnosed as Pituitary adenoma by histopatholgy. In NCCT, the tumors were hypodense in 87% and isodense in 13% cases. Calcification was present in 87.5% cases and contrast enhancement was seen in 100% cases. These findings were supported by others[14].

The overall accuracy of CT as diagnostic modality was 95% to 97% in preoperative diagnosis of brain tumor in this study, which is almost similar to study done by others in similar settings.

From the result of the present study as well as the findings obtained by other investigators, it is conceivable that CT is one of the accurate diagnostic modalities in the evaluation of pediatric brain tumors.

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