COMPUTERIZED TOMOGRAPHIC SCANNING OF BRAIN FOR EVALUATION OF CHILDREN WITH DELAYED MILESTONES

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Abstract

Objective: To assess the utility of Computerized Tomographic (CT) scanning of brain in the evaluation of children with delayed milestones.
Study Design: Cross-sectional retrospective study.
Place and Duration of Study: Department of Radiology, Pakistan Air Force Hospital, Islamabad from April 2007 to September 2009.
Patients and Methods: We retrospectively reviewed the referral forms of CT scanning of brain for evaluation of children with delayed milestones. A total of 48 patients had a CT brain for evaluation of delayed milestones. They were divided into two groups. There were 15 patients in group A, who had significant history and clinical findings. Group B had 33 patients, in whom there was no clue to the etiology of developmental delay. The results of their CT scans of brain were compiled and analyzed.
Results: Out of a total of 15 patients in group A, fourteen (93.3%) had an abnormality. Mild cerebral atrophy was seen in 11 patients, two had calcification in basal ganglia and one had leukodystrophy. No abnormality was seen in CT scan of brain in group B patients.
Conclusion: CT scanning of brain is useful in reaching a diagnosis of delayed developmental milestones where there are significant historical and abnormal physical findings.

Keywords : Children, CT scanning, Delayed milestones.

Article

INTRODUCTION

Neurodevelopmental disabilities are challenging for primary care physician and pediatrician, for early recognition, accurate diagnosis, determination of etiology and further management1. If after a comprehensive history and clinical examination, a specific diagnosis is suspected, then investigations should be selective and guided by clues in history and examination2. Neuroimaging is an essential tool for the evaluation of many disorders of childhood3. Neuroimaging should be considered in patients with abnormal head size, focal neurological signs, neurocutaneous disorders and any unexpected change in child's condition. Magnetic resonance imaging (MRI) is the investigation of choice although CT scanning is better for bone structure and calcifications in brain. In the absence of significant historical and physical findings, CT scanning would not be of much help. Many of children with delayed milestones are advised CT scanning of brain rather than MRI because of less availability of MRI as compared to CT scanning as well as parents' apprehension of hazards of general anesthesia required for MRI. CT scanning should be avoided where expectations of positive findings is negligible because intellectual development is adversely affected when the infant brain is exposed to ionising radiation at doses equivalent to those from computed tomography of the brain4. It is the duty of pediatricians and radiologists to collaborate with each other in minimizing the radiation exposure to young children.

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PATIENTS and METHODS

We received patients from PAF Hospital and Naval Hospital, Islamabad. Four different pediatricians of these two hospitals had referred these patients for CT scanning, during the study period. A total of

48 CT scans of brain were done from April 2007 to September 2009, for evaluation of children with delayed milestones. Scanning was done with six slice Brilliance 6 (Philips) scanner. Age of the patients ranged from 4 months to 11 years. Twenty nine were males and nineteen were females. Of all the patients 14 were infants aged 4 to 12 months. All scans were plain and intravenous contrast was not required in any of the patients. Patients were divided into two groups. In group A there were 15 patients who had significant history of perinatal, postnatal or childhood problems and there were remarkable findings on clinical examination. Group B comprised 33 patients in whom there was no clue from the history or clinical examination for the cause of developmental delay. The results of their CT scans were retrieved from the record register in radiology department and compiled.

RESULTS

Out of 15 patients in group A, fourteen (93.3%) had an abnormality. One patient had leukodystrophy, who was advised to have MRI of brain for further evaluation. Two patients had calcification in basal ganglia while mild cerebral atrophy was the only abnormality in 11 patients. No cause for this atrophy was detectable on CT scanning. No abnormality was seen in CT scan of brain in 33 patients in group B.

Table: Showing clinical feuture and key physical findings in Group A patients

Group A Patients		
Historical Features	**Key Physical Findings/ Disorder**	**Number of patients**
Perinatal asphyxia/ anoxia neonatal seizures	Cerebral palsy	7
Rash, flu like illness, poor feeding, failure to thrive, icterus	Microcephaly, jaundice, cataract, hepatospleenomegaly/ TORCH	3
Extreme prematurity	Cerebral palsy (diplegic)	1
Family history of microcephaly	Familial microcephaly	1
Epileptic seizures	Adenoma sebaceum/ neurocutaneous disorder	1
Family history of regression of developmental milestones	Degenerative brain disorder	1
Slight dysmorphism	Cognitive disorder	1

DISCUSSION

Imaging plays an important role in the diagnosis of developmental delay. MRI is the investigation of choice as it is capable of detecting abnormalities in up to 50% of children who have neurodevelopmental disability and is not harmful to the child. Proton magnetic resonance spectroscopy (MRS) provides the mechanism of measuring the biochemistry of brain on regional basis and is useful in diagnosis of certain genetic & metabolic conditions5. Advances in neuroimaging, specifically diffusion tensor imaging (DTI) which detects the position & direction of major white matter tracts in central nervous system, is capable of detecting more subtle abnormalities that underlie the global developmental delay. CT scanning is useful where there is abnormal head size & shape, focal seizures, focal neurological findings, skin stigmata of neurocutaneous disorders. It also detects the calcifications in various endocrine, metabolic, infectious or neoplastic disorders better.

Only Patients in group B with global developmental delay who had no abnormal physical findings pointing to a specific etiology had a normal CT of brain. These were probably the children with cognitive disorders due to learning disability. They require exhaustive work-up including cytogenetic screen/FraX, metabolic testing, EEG, MRI and tests for subtelomeric rearrangements. Even with such an extensive work-up the etiology is hardly found in 50% of patients6. A study was conducted at Pakistan Institute of Medical Sciences, Islamabad, Pakistan, in which imaging findings of patients with degenerative brain diseases were evaluated. It showed that 77% of patients had an abnormal finding on CT scanning of brain while 2 out 5 patients had an abnormality on MRI of brain. Despite abnormal clinical findings still some of the patients had normal scans in this study7.

CT scanning uses ionizing radiation which is harmful to the intellectual development of child. It also increases the risk of fatal cancers later in life. In a study8 conducted at Center for Radiological Research, Columbia University, New York, it has been estimated that, the lifetime cancer mortality risks attributable to radiation from a pediatric CT examination are considerably higher than for adults. For example, the lifetime cancer mortality risk attributable to the radiation exposure from a single head CT examination in a 1-year-old child is approximately one in 1500. In comparison it has been estimated that one CT scan of head in a 5-year old, gives a radiation dose equivalent to one

hundred chest radiographs3. Although the brain was once considered a comparatively radioresistant organ, more recent data suggest that it is significantly radiosensitive, particularly at very low doses, with the risk increasing with decreasing age. The risk estimates given in this study are for lifetime cancer mortality; estimated cancer risks from pediatric CT examinations would be larger, particularly for CT examinations of the head, because of the larger contribution of radiation-induced thyroid cancer.

Apart from the risk of cancer there is adverse effect on cognitive abilities of children whose brain is exposed to low doses of radiation in infancy. In a Swedish population based cohort study4, it was found that the proportion of boys who attended high school decreased with increasing doses of radiation to brain from about 32% among those not exposed to around 17% in those who received more than 250 mGy of radiation. It is therefore necessary to be very careful in advising a CT scan of brain for infants and young children for delayed milestones.

The MRI is not easily available and long waiting periods are common due to paucity of scanners. It is better to wait for this harmless investigation rather than doing a harmful CT scan for evaluation of developmentally delayed child. MRI is the imaging modality of choice for the infant or child with developmental delay because of its superior sensitivity & specificity for demonstrating abnormal brain anatomy and function12. MRI provides more complete delineation of complex CNS anomalies for diagnosis, treatment, prognosis and genetic counseling.

Ultrasonography (USG) is useful for the evaluation of the neonate with possible hypoxia-ischemia or intracranial hemorrhage. It can also be used as an initial screening procedure in neonate & young infant with developmental delay9. USG is easily available and harmless imaging modality but may not answer the clinical query. In such cases MRI should be the next investigation of choice.

It is the responsibility of radiologist to try to minimize the radiation exposure to infants and young children. If the CT scan is considered necessary, then the radiologist can reduce the radiation dose to children by reducing the tube current (mA). A 50% reduction in tube current results in a decrease in radiation dose by 50%10. The major disadvantage of decreasing the mA is an increase in noise and the associated potential for degradation of image quality. However, smaller patients attenuate the X-ray beam less, resulting in more photons reaching the detector and, therefore, less noise. Thus, the potential for increased noise caused by decreasing the tube current in younger patients is counterbalanced by the smaller size of the younger patients. In our department we have made new protocols for CT scanning of infants and children with decreased mA.

CONCLUSION

CT scanning of brain is an important investigation in the work up of child with delayed milestones when comprehensive history and clinical examination point towards a structural brain defect. As the ionizing radiation to brain of infants & young children can cause adverse effects on intellectual development and increases the risk of fatal cancers, it is better to avoid CT scanning. MRI & USG should be used for evaluation and to reassure the parents. If the facility of MRI is not available then CT scanning can be considered but the radiologist should try to minimize the radiation dose to the child by changing the CT parameters as far as possible.

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