ORIGINAL RESEARCH PAPER
Volume - 13 | Issue - 11 | November - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ROLE OF MR SPECTROSCOPY IN DIAGNOSIS OF PAEDIATRIC BRAIN LESIONS.

Radio-Diagnosis

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ABSTRACT

Context: Magnetic resonance imaging (MRI) is a non-invasive Technique for diagnosis, grading, and post-treatment follow-up of pediatric brain tumors. Although it is considered the gold standard for the evaluation of brain tumors, in many instances, reliable differentiation of neoplastic from non-neoplastic brain lesions or of high from low-grade tumors are difficult with conventional MRI. Neuro-Imaging plays an invaluable role in the diagnosis, treatment, and monitoring of pediatric brain tumors. While traditional imaging techniques are good at detecting pediatric brain cancer, they offer low specificity, lack of histological correlation and have limited capacity to evaluate therapeutic response evaluation. MR spectroscopy (MRS) can assess pediatric neurological abnormalities at microscopic levels by quantifying cellular metabolites and studying their distribution in the tissues. MR spectroscopy has been proven to provide additional clinically relevant information for several pediatric neurological disease processes such as brain tumors, infectious processes, white matter disorders, and neonatal injury. Aims: To assess the radiological profile of pediatric brain lesions on magnetic resonance imaging, The role of MR Spectroscopy in pediatric brain lesions & To correlate the MRS findings with clinical profile, histo-pathological findings wherever possible. **Settings and Design:** Prospective type of Research study, which is performed after approval of research proposal by Institutional Ethics Committee (I.E.C.). **Material and Methods:** MR examinations were performed using a 1.5 T scanner. The protocol includes MRI Brain scan with T1W, T2W, DWI & ADC, FLAIR, and SWI Sequences in Axial modes. T1W Coronal & T2W sagittal images are also taken. Post contrast T1W with fat saturation coronal, axial & sagittal Sequences were taken. And then After Multi Voxel Spectroscopy Were Performed. **Statistical Analysis:** The data were analyzed by using of Spss program 16.00 version and Sensitivity and specificity were calculated to depict diagnostic accuracy. **Results:** The Study found that MR Spectroscopy Plays crucial role in the diagnosis and characterization of various intracranial space occupying lesions in pediatric patients. Besides differentiation of benign from malignant lesions. It also helps in the grading of malignancies. MR Spectroscopy and it correlation with the Clinical Profile and histo-pathology which also helps in the confirmation of the different brain lesion in the Pediatric Patients. This study also concludes that MRS should be used in combination with MRI. Single voxel spectroscopy is shown to be a valuable characterization tool for use in pediatric brain tumors. **Conclusion:** MR spectroscopy Technique is a most sensitive for diagnosis of the pediatric brain Lesions.

KEYWORDS

Magnetic Resonance Imaging, Magnetic Resonance Spectroscopy, Pediatric Brain Lesions

INTRODUCTION

Pediatric neurological lesions are a diverse group of diseases which include tumors, abnormal blood vessel formation, abscess, inflammation due to infections and metabolic disorders etc. The age of the patient, the imaging characteristics and location of the lesions is the key for establishing the diagnosis. The pediatric neurological disorders account for more than 20% of the world's disease burden with a greater majority of people affected in Africa. The factors affecting pediatric neurological diseases include malnutrition, adverse perinatal conditions, malaria, acquired immune deficiency syndrome, meningo-encephalitis, demographic transitions, and persistent regional conflicts.[1]

Primary brain tumors are the second most common after leukemia's in children. Supra-tentorial tumors are more common in neonates and children upto 2 years of age whereas infra-tentorial tumors are more common in children older than 2 years. Approx 50% of brain tumors in children are infra-tentorial. The incidence of pediatric brain tumors varies from country to country and ranges between 1-5 per100, 000. In United States about 4600 primary central nervous system tumors are diagnosed annually.[2]

There are over 100 histologic sub types of brain tumors, but the most commonly diagnosed brain tumors in children are low-grade gliomas, especially Pilocytic astrocytoma with an incidence of 0.8 per 100000 and Medulloblastoma with an incidence of 0.4 per 100,000. [3] The prognosis of pediatric brain tumors depends on the age of presentation, histological type and extent of resectability. Congenital brain tumors (CBT) behave in different way than pathologically similar tumors in older children. For example, low-grade gliomas show increased aggressiveness while high-grade gliomas exhibit slightly better prognosis in very young children in comparison to their older counterparts. Brain tumors are the leading cause of death in children due to poor outcomes of recurrent malignant tumors. [4,5]

Metabolic disorders in pediatric age group are divided into acquired disease and inborn errors of metabolism (IEM). Acquired metabolic diseases usually occur in specific clinical settings, such as kernicterus in neonatal hyper-bilirubinemia, hypo-vitaminoses in malnutrition or neontatal hypoglycemia in premature infants and toxic encephalopathies (exogenous forms of acquired metabolic diseases).

The presenting symptoms are usually non-specific such as seizures, spasticity, ataxia, movement disorder or delay in achieving the developmental milestones Inborn errors of metabolism represent a vast and complex group of pathologies due to a mutation resulting in a biochemical alteration involving one or more metabolic pathways. Individual IEM are rare disorders, most having an incidence of less than 1 per 100,000 births. However, when considered collectively, the incidence may approach 1 in 800 to 1 in 2500 births.[6]

Aims & Objectives:-

- To assess the radiological profile of pediatric brain lesions on magnetic resonance imaging.
- To evaluate the role of Magnetic Resonance Spectroscopy in brain lesions of pediatric patients.
- To correlate the MRS findings with clinical profile and Histo-pathological findings wherever possible.

MATERIAL & METHODS:-

Study Design: - A Prospective and Observational Research study was a performed on 50 Patients. (After approval of research proposal by Institutional Ethics Committee (I.E.C.).

After taking informed consent from the parents/ relatives of the patient detailed history and clinical examination of the patients with suspected neurological disease was done and recorded on predesigned proforma. Routine investigations like CBC, RFTs, LFTs, ESR/CRP were done. Relevant serological tests were performed wherever required.

MRI was performed on Siemens "MAGNETOM Avanto" 1.5 Tesla system. The Sedation was given whenever required to avoid motion during the study and in claustrophobic patients. It was administered orally or intravenously before the starting of the study under the supervision of an attending anesthetist.

MR examinations were performed using a 3T scanner. The protocol includes non-contrast MRI scan with T1W, T2W, T2 GRE, and SWI sequences were taken in axial planes. T2W Coronal and T1W Sagittal is also Taken. And post contrast T1W with fat saturation coronal, axial & sagittal images was taken. The slice thickness was 3 to 5 mm. The overall duration of the examination was 20 -25 minutes.

MR Spectroscopy was performed using of the 2d multi-voxel (chemical shift imaging) which covered a large volume of tissue. Multi-voxel Point Resolved Spectroscopy (PRESS) sequence was used with TR of 1500 ms, TE of 135 ms, NEX is 4. Stimulated Echo Acquisition Mode (STEAM) sequence was used for low peak metabolite with TR 1500, TE 20 and NEX is 4. Post processing was done and spectroscopy graph was obtained.

RESULTS

The mean age of patients was 12.86 ± 6.51 years. More than half of patients were males (54%). Majority of deliveries were normal (70%). Normal crying after birth was among majority of patients (72%). SOL was the most common clinical diagnosis (18%). Meningitis was the second most common clinical diagnosis (16%). Low grade glioma was the most common radiological finding. High grade glioma was the second most common radiological diagnosis accounted 24%. Cyst was in 10% patients. Elevated lipid lactate peak (3.8 ppm). Decreased NAA/Cho and NAA/Cr was the most common MRS finding (22%). Significant increased Cho/cr ratio. Decreased NAA level was the second most common MRS finding (14%). Non- specific spectroscopy findings were the third most common MRS finding (12%). High grade glioma was the most common histo-pathological diagnosis (38.7%).

Low grade glioma was the second most common histo-pathological diagnosis (39%). Tuberculoma was the third most common histo-pathological diagnosis (19.4%). Billirubin encephalopathy was diagnosed by clinical and radiological diagnosis. There was 96.8% agreement between histo-pathological diagnosis and radiological diagnosis.

Decrease NAA and choline level and Elevated CHO and decreased NAA were in one case in which radiological diagnosis was Low grade glioma. Increased Cho and lipid levels decreased Cr levels MRS finding was in one case in which histo-pathological diagnosis was Low grade glioma.

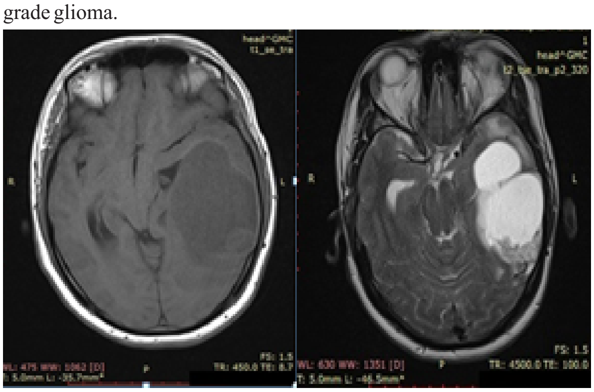

Fig.1:- T1W Hypo-intense solid cystic mass in left Temporo-parietal region.
Fig.2:- The Lesion appears Hyper intense in T2W Sequence.

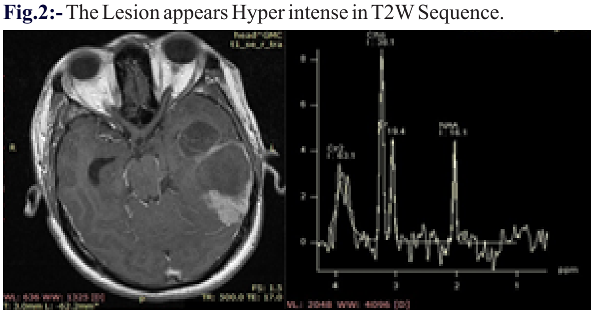

Fig.3:- In the post contrast study the lesion shows that heterogeneous peri-pheral enhancement.
Fig.4:- Magnetic Resonance Spec-troscopy finding shows increased Choline peak and decreased NAA that is Suggestive of the High grade glioma.

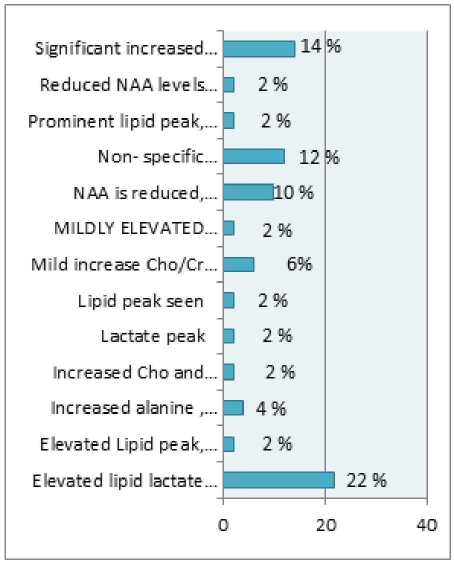

Fig: 5. Distribution of patients according to MR Spectroscopy findings.

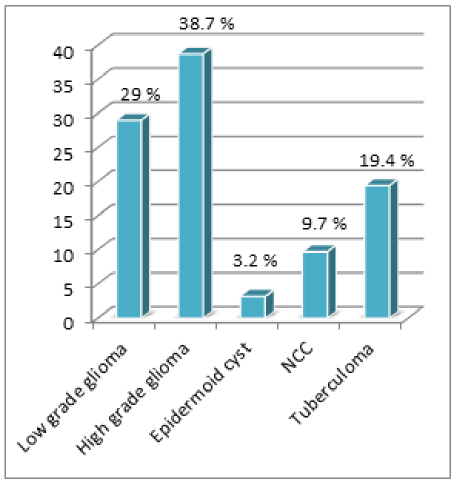

Fig:-6. Distribution of patients according to histo-pathological findings.

DISCUSSION

Magnetic Resonance Spectroscopy is an advanced and non-invasive technique and has a potential for providing the information about the composition of various lesions. It is a useful method for determining the molecular structures which provides the metabolic information from viable brain tissues the development of improved techniques for spatial localization and water suppression (MRS) provides metabolic information regarding the tissue under study, complementing the anatomic information obtained with conventional MRI. For a reliable MRS procedure, spectroscopic localization methods and data acquisition should be properly adjusted. Metabolites which can be detected in the brain tissue include Choline, Creatinine, N-acetyl Aspartate (NAA), lactate, Myoinositol, Glutamine/ glutamate, Lipids, and Amino acids. Brain lesions contain abnormal level.[7,8]

In the present study, SOL was the most common clinical diagnosis (18%). Meningitis was the second most common clinical diagnosis (16%).The study of Pandit et al (2017) 49 found that patients presented with generalized seizure in 76%, focal in 16%, headache ± vomiting in 6%, focal neurodeficit in 2% and combination of symptoms in 60.5% cases. MRI brain showed a solitary lesion in 45 (90%) and multiple in 5 (10 %). At presentation lesions were vesicular in 46%, nodular calcified in 16 %, granular nodular in 10 %, colloidal vesicular in 6% and mixed in 6%. One child presented with a starry sky appearance. This study found that low grade glioma was the most common radiological finding. High grade glioma was the second most common radiological diagnosis accounted 24%. Cyst was in 10% patients.[9]

In the present study, elevated lipid lactate peak, Peak at 3.8 ppm. Decreased NAA/Cho and NAA/Cr was the most common MRS finding (22%). Significant increased Cho/Cr ratio decreased NAA level was the second most common MRS finding (14%). Non- specific spectroscopy findings were the third most common MRS finding (12%). High grade tumors possessed higher Cr levels.

Decreased NAA level was the second most common MRS finding (14%) in the present study. Previous studies have found higher tNAA in PA compared to other cerebellar tumours, although not significant (Davies et al, 2008). Total N-acetyl aspartate is a known marker of neuronal and axonal integrity and most reliable marker of pathological disease in the brain (Gujar et al, 2005). It does not appear to provide information on tumour metabolism and instead mostly used as a cell type marker. For example increased tNAA in DIPG is likely to be due to the diffuse nature of the tumour (Hargrave et al, 2008)68. However, the contribution of tNAA in vivo metabolite profiles of PA requires further investigation.[10,11]

In the present study, high grade glioma was the most common histo-pathological diagnosis (38.7%). Low grade glioma was the second most common histo-pathological diagnosis (39%). Tuberculoma was the third most common histo-pathological diagnosis (19.4%). In this study, there was 96.8% agreement between histo-pathological diagnosis and radiological diagnosis.

CONCLUSIONS

- About one third of patients were 11-15 & >15 years (32%) followed by 5-10 (28%) and < 5 (8%) years.
- The mean age of patients was 12.86 ± 6.51 years.
- More than half of patients were males (54%).
- Majority of deliveries were normal (70%).
- Normal crying after birth was among majority of patients (72%).
- SOL was the most common clinical diagnosis (18%). Meningitis was the second most common clinical diagnosis (16%).
- Low grade glioma was the most common radiological finding. High grade glioma was the second most common radiological diagnosis accounted 24%.
- Cyst was in 10% patients.
- Elevated lipid lactate peak, Peak at 3.8 ppm. Decreased NAA/Cho and NAA/Cr was the most common MRS finding (22%).
- Significant increased Cho/Cr ratio decreased NAA level was the second most common MRS finding (14%).
- Non- specific spectroscopy findings were the third most common MRS finding (12%).
- High grade glioma was the most common histo-pathological diagnosis (38.7%).
- Low grade glioma was the second most common histo-pathological diagnosis (39%).
- Tuberculoma was the third most common histo-pathological diagnosis (19.4%).
- Billirubin encephalopathy was diagnosed by clinical and radiological diagnosis.
- There was 96.8% agreement between histo-pathological diagnosis and radiological diagnosis.
- Decrease NAA and choline level and Elevated CHO and decreased NAA were in one case in which radiological diagnosis was Low grade glioma.
- Increased Cho and lipid levels decreased Cr levels MRS finding in one case in whose histo-pathological diagnosis was Low grade glioma.
- This study concludes that MRS should be used in combination with MRI. Single voxel spectroscopy is shown to be a valuable characterization tool for use in paediatric brain tumours.

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