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ADVANCED MRI IMAGING TECHNIQUES IN EVALUATION OF PAEDIATRIC BRAIN TUMOURS

Radiodiagnosis

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ABSTRACT

Routine brain MRI is many times not able to detect certain important features of the pediatric brain tumors and many times have limited role. Advanced brain MRI techniques are very much helpful to improve diagnostic performance in pediatric patients of the brain tumors. Advanced MRI techniques used for evaluating pediatric brain tumors include diffusion-weighted imaging, diffusion tensor imaging, perfusion imaging and spectroscopy. In this study, we review advanced MRI techniques and interpretation algorithms for pediatric brain tumors.

KEYWORDS

Brain tumors, Pediatrics, Magnetic resonance spectroscopy, Diffusion-weighted imaging, Perfusion imaging

Objectives of Study

- To study the distribution of various supratentorial and infratentorial neoplasms.
- To study various MRI features of supratentorial and infratentorial neoplasms
- To develop imaging strategy for evaluation of supratentorial and infratentorial tumors

Materials And Methods:

- **Source of Data**
- All cases referred to Department of Radio diagnosis and Imaging in LTMMC and LTGH, SION, MUMBAI for radiological evaluation with h/o intracranial space occupying lesions.
- **Duration of study :** AUGUST 2016- JULY 2017 (minimum of 20 cases)

*a) **Inclusion criteria***: Clinically diagnosed patients below 18 years of age groups with supratentorial and infratentorial tumors will be included.

*b) **Exclusion criteria*** : All cases with -

- Patients above age of 18 yrs
- Congenital malformations
- Trauma or cerebrovascular accidents will be excluded.

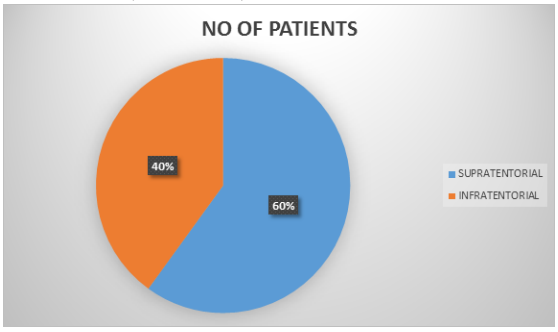
- **Method of Collection of Data**

It is a cross sectional study. All patients will be subjected to a multiplanar MRI Scan of the brain in a 3 Tesla Philips Machine and further follow up of patients for histopathological correlation wherever possible.

- **RESULTS**

The 20 malignancies included in this study were further categorized by site into two groups,

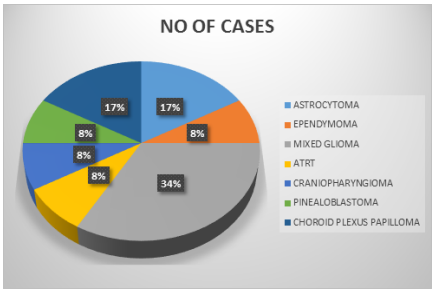
1) Supratentorial (12 cases; 60%) and
2) Infratentorial (8 cases; 40%).



The morphological categorization of supratentorial tumors was

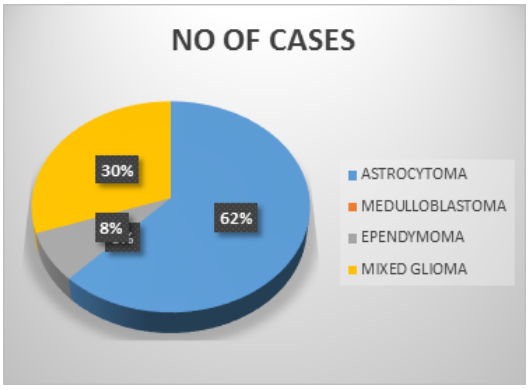
1) Astrocytoma (2 cases; 16.66 %),
2) Ependymoma (1 cases; 8.33 %),
3) Mixed glioma (4 cases; 33.33 %),
4) ATRT, (1 case, 8.33 %)
5) Craniopharyngioma (1 case, 8.33 %) and
6) Pinealoblastoma (1 case, 8.33 %).
7) Choroid plexus papilloma (2 cases, 16.66%)

The supratentorial astrocytoma were graded as follows - pilocytic astrocytoma (1 case), grade II astrocytoma (no cases); grade III astrocytoma (no cases), anaplastic astrocytoma (no cases) and glioblastoma multiforme (1 case).



The morphological categorization of infratentorial tumors was

1) Astrocytoma (3 cases, 37.5%),
2) Medulloblastoma (0 cases),
3) Ependymoma (1 cases, 12.5 %) and
4) Mixed glioma, (4 cases, 50 %)



The morphological categorization of infratentorial astrocytoma was pilocytic astrocytoma (3 cases) with gemistocytic astrocytoma, grade II astrocytoma, grade III astrocytoma, and anaplastic astrocytoma.

AGE DISTRIBUTION

This included 14 (70 %) cases in males and 6 (30%) in females. A distinct male predominance was noted in all histological types. The cases of the present study were divided into 3 age groups each covering six years of life (0-6, 6-12, 12-18 years) to highlight the sex distribution and age frequency amongst each age-group band. The maximum number of cases (11 cases) were observed in the second age

group i.e. 6-12 years followed by 7 cases in the third age group i.e. 12-18 years and the least cases (2 cases) were observed in the youngest (0-6 years) age group. The youngest case was a 3 month male baby suffering from ATRT (Atypical Teratoid / Rhabdoid tumour)

TABLE I:

AGE	NO OF PATIENTS	PERCENTAGE
0-6 YRS	2	10%
6-12 YRS	11	55%
12-18 YRS	7	35%

CHART 1:

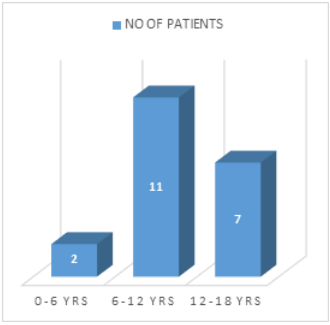
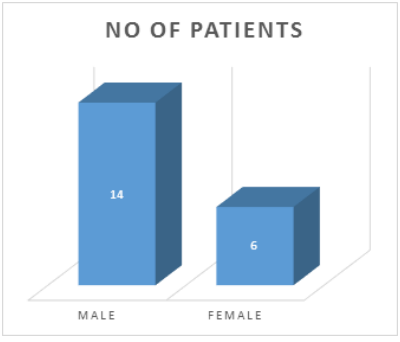


TABLE II: SEX DISTRIBUTION

	N	%
Male	14	70%
Female	6	30%
Total	20	100%

CHART II:



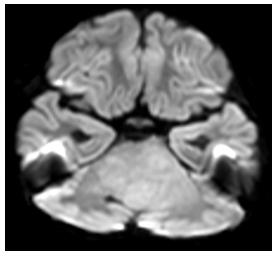
• DISCUSSION

Brain tumors are the most common solid tumor and a leading cause of death in children. Evaluating pediatric brain tumors is often a diagnostic challenge due to their diverse tumor pathologies, nonspecific or overlapped imaging findings, recent evidence of gadolinium deposition in the brain, susceptibility artifacts from intratumoral calcification or hemorrhage, susceptibility artifacts related to tumor locations close to the skull base, and limited signal-to-noise ratios (SNRs) and motion artifacts in young children. The initial diagnosis of pediatric brain tumors is almost always based on patient age, tumor location, and neuroimaging findings. Beside the initial diagnosis, other goals of brain MRI for pediatric brain tumors should include differentiation of specific tumor types, grading tumors, distinguishing viable tumor from necrotic tissue, guiding stereotactic biopsy, and determining treatment responses.

As conventional anatomic brain MRI is often limited in achieving these goals, advanced MRI techniques, such as diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI), perfusion imaging, MR spectroscopy (MRS), and susceptibility-weighted imaging (SWI), are commonly included in the MRI protocol. Regarding field strengths of MRI systems, 3T is the current standard of neuroimaging mainly due to higher contrast-to-noise ratio and SNR.

DIFFUSION WEIGHTED IMAGING

Diffusion-weighted imaging provides qualitative and quantitative assessments of water diffusion in brain tumors, reflecting tumor cellularity. To avoid the so-called T2-shine-through effects possibly leading to false positive diagnosis on DWI, whether a hyperintense area on DWI also shows restricted water diffusion (hypointensity) on the apparent diffusion coefficient (ADC) map should be confirmed. Low ADC values in pediatric brain tumors generally suggest high-grade hypercellular tumors, such as medulloblastoma, primitive neuroectodermal tumor, and glioblastoma, whereas low-grade gliomas usually show high ADC values. However, considerable overlap of ADC values between high- and low-grade tumors in both pediatric and adult patients results in limited clinical value of DWI for tumor grading. In addition, ADC values are affected by the presence of intratumoral hemorrhage and calcification frequently included in pediatric brain tumors.



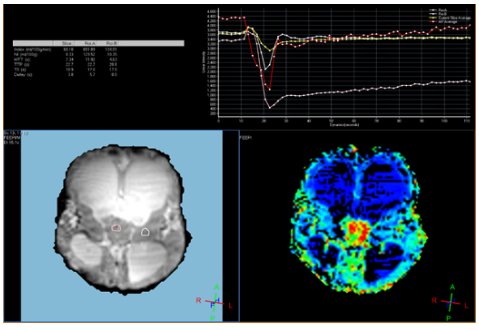
DIFFUSION TENSOR IMAGING

In contrast to DWI, DTI with at least 6 diffusion-sensitizing gradient directions provides anisotropic water diffusion in the brain mostly caused by the white matter tracts. The degree and the direction of the anisotropic water diffusion are demonstrated by fractional anisotropy (FA) map and color-coded map. Tumor infiltration in peritumoral edema may be delineated exclusively on DTI but not on other MRI techniques. Fiber tractography reconstructed from DTI data is essential for surgical planning, particularly in brainstem and supratentorial tumors, by illustrating spatial relationships between major functional fibers, such as motor, language, and visual tracts, and brain tumors.

However, diagnostic pitfalls of fiber tractography caused by crossing fibers, false negative findings, image distortion due to magnetic susceptibility artifacts, and intraoperative brain shifting, should be considered to avoid misinterpretation. In addition, FA values are potentially useful for evaluating radiation-induced white matter injury in pediatric brain tumors.

PERFUSION IMAGING

Perfusion MRI providing the degree of neovascularity or tumor angiogenesis at tissue level is useful for tumor grading and prognostication. Three types of perfusion MRI techniques include dynamic susceptibility contrast (DSC) imaging, dynamic contrast-enhanced (DCE) imaging, and arterial spin labeling (ASL) imaging. An exogenous contrast agent is used in DSC imaging and DCE imaging, while no exogenous contrast agent is necessary in ASL imaging. DSC imaging is the standard perfusion MRI method that is widely used in brain tumors, while DCE imaging is regarded as a viable alternative. ASL imaging, especially promising in children, is still evolving and improving to gain more clinical acceptance. There is a growing concern of gadolinium accumulation in the brain, such as the dentate nucleus and globus pallidus, in patients with normal renal function following multiple gadolinium-based contrast-enhanced MRI examinations. As in nephrogenic systemic fibrosis, the macrocyclic gadolinium chelates are more stable and, therefore, less accumulated in the brain than the linear chelates. Although the clinical significance of this gadolinium deposition remains to be elucidated, contrast-enhanced perfusion MRI, such as DSC and DCE, should be carefully performed in children with brain tumors. In this regard, non-contrast perfusion MRI, such as ASL imaging, is a valuable alternative to contrast-enhanced perfusion MRI, particularly in children.

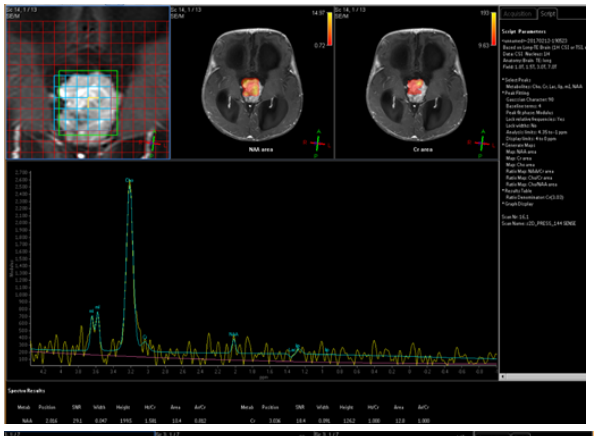


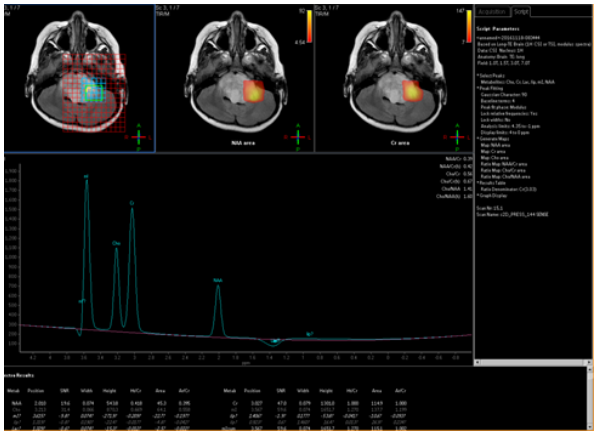
MR SPECTROSCOPY

Proton MRS is divided into single-voxel and multi-voxel (MR spectroscopic imaging) methods depending on the number of voxels used for MRS, and into short (20–40 ms), intermediate (135–144 ms), and long echo time (270–280 ms) methods depending on echo times. Single-voxel method is generally used in clinical practice because multi-voxel method shows limited spectroscopic quality and spatial resolution.

Longer echo time methods demonstrate fewer metabolites with long T2 relaxation times, such as N-acetylaspartate (NAA), choline (Cho), and creatine (Cr), as compared to short echo time method, but the baseline tends to be less fluctuating with longer echo time methods. An inverted doublet at 1.3 ppm at echo time of 144 ms is useful to identify a lactate peak. Compared with longer echo time methods, short echo time method allows the detection of additional metabolites, including taurine (Tau), glutamine plus glutamate, myoinositol (mI) plus glycine, and alanine (Ala), that occasionally give a diagnostic hint to a specific tumor type. The pulse sequences used for MRS include point resolved spectroscopy (PRESS) and stimulated echo acquisition method (STEAM).

Chief metabolites on MRS include NAA (a neuronal marker), Cho (a marker of active membrane turnover), Cr (an energy metabolism marker), mI (a glial marker), and lactate (a marker of anaerobic glycolysis), and each metabolite is identified at a specific ppm. The hallmark of MRS findings of brain tumors is elevated Cho and decreased NAA levels, often presented with metabolite ratios, such as Cho/Cr and NAA/Cr ratios. High-grade tumors usually have higher Cho/Cr and lower NAA/Cr ratios than low-grade tumors. Lactate/lipid peaks reflect necrotic high-grade tumors. However, the MRS pattern suggesting high-grade tumors is typically seen in pilocytic astrocytoma (WHO grade I). MRS has potential to differentiate between different type of pediatric brain tumors according to their different metabolites.





• CONCLUSION

Probable MRI diagnosis of pediatric brain tumors in clinical practice are usually based on diagnostic clues including tumor location, patient age, clinical history, tumor incidence, and MRI findings. Of importance, advanced brain MRI techniques provide incremental diagnostic value over conventional MRI. However, no single advanced technique is perfect but different techniques typically complement one another. To narrow the differential diagnosis of pediatric brain tumors by using these advanced techniques, identification of findings that are inclusive, exclusive, or highly suggestive is required. Furthermore, functional and pathophysiologic information obtained by advanced brain MRI may provide valuable insights into various imaging phenotypes of pediatric brain tumors and increase the understanding of the link between imaging phenotypes and genotypes. This will become more important with advancement of increasingly individualized and sophisticated management strategies.

REFERENCES

1. Barkovich AJ. Pediatric Neuroimaging. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2005.
2. Panigrahy A, Blüml S. Neuroimaging of pediatric brain tumors: from basic to advanced magnetic resonance imaging (MRI) J Child Neurol. 2009;24:1343–1365. [PubMed]
3. Radbruch A, Bendszus M. Advanced MR imaging in neurooncology. ClinNeuroradiol. 2015;25(Suppl 2):143–149. [PubMed]
4. Rossi A, Gandolfo C, Morana G, Severino M, Garrè ML, Cama A. New MR sequences (diffusion, perfusion, spectroscopy) in brain tumours. PediatrRadiol. 2010; 40:999–1009. [PubMed]
5. Poretti A, Meoded A, Huisman TA. Neuroimaging of pediatric posterior fossa tumors including review of the literature. J MagnReson Imaging. 2012;35:32–47. [PubMed]
6. Lacerda S, Law M. Magnetic resonance perfusion and permeability imaging in brain tumors. Neuroimaging Clin N Am. 2009;19:527–557. [PubMed]
7. Romano A, Rossi Espagnet MC, Calabria LF, Coppola V, Figà Talamanca L, Cipriani V, et al. Clinical applications of dynamic susceptibility contrast perfusion-weighted MR imaging in brain tumours. Radiol Med. 2012;117:445–460. [PubMed]
8. Plaza MJ, Borja MJ, Altman N, Saigal G. Conventional and advanced MRI features of pediatric intracranial tumors: posterior fossa and suprasellar tumors. AJR Am J Roentgenol. 2013;200:1115–1124.[PubMed]
9. Borja MJ, Plaza MJ, Altman N, Saigal G. Conventional and advanced MRI features of pediatric intracranial tumors: supratentorial tumors. AJR Am J Roentgenol. 2013;200:W483–W503. [PubMed]
10. Vinogradov E, Sherry AD, Lenkinski RE. CEST: from basic principles to applications, challenges and opportunities. J MagnReson. 2013;229:155–172. [PMC free article] [PubMed]
11. Goo HW. High field strength magnetic resonance imaging in children. J Korean Med Assoc. 2010;53:1093–1102.