

Infratentorial Brain Tumors in Children: The Value of Magnetic Resonance Imaging (MRI) in the Differential Diagnosis

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Abstract: Background and Aim of the Work: Brain tumors are the most common solid tumor in children and are the second most common neoplasm in childhood after hematological malignancies, and accounts for 20% of all pediatric cancers. Approximately half of all intracranial neoplasms in children are found within the posterior fossa. Conventional magnetic resonance imaging is the corner stone in the initial evaluation of pediatric brain tumors. The purpose of this study was to assess the role of MRI in differential diagnosis of infratentorial brain tumors in children by MRI. Patients and Methods: This study was carried out on 30 patients (17 male, 57% and 13 female, 43%), their age ranged from 4 – 11 years old with the mean age 7.5 years. All patients were selected according to their presentation with cranially related manifestations and all were subjected to full history, full clinical data and radiological examination by MRI. Results: The MRI evaluation and histopathological reports showed that: 10 cases of cerebellar juvenile pilocytic astrocytoma (33%), 10 cases of medulloblastoma (33%), 4 cases of infratentorial ependymoma (13%), 5 cases of brain stem glioma (17%) and one case of atypical teratoid rhabdoid tumor (3%). Conclusion: Magnetic resonance imaging (MRI) is the primary imaging modality used for the assessment of intracranial tumors as MRI provides superior delineation of the extent of tumor.

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1. Introduction

Approximately half of all intracranial neoplasm in children are found within the posterior fossa⁽¹⁰⁾. Infratentorial brain tumors are more frequent in the first decade than tumors in the supratentorial compartment⁽¹⁴⁾.

Infratentorial tumors are the most frequent, mostly encountered between 4 and 11 years of age⁽⁴⁾.

The decrease in brain tumours incidence and mortality reflects progress in cancer prevention, early detection, and treatment⁽²⁾.

For practical purpose, the posterior fossa tumors can be divided into the following anatomic locations: 1. Cerebellar and/or fourth ventricle tumors, 2. Brain stem neoplasm, 3. Extra – axial neoplasm⁽⁸⁾.

More than 80% of posterior fossa tumors arise within the fourth ventricle and cerebellar hemisphere. The most common cerebellar and fourth ventricle tumors and medulloblastoma (primitive neuroectodermal tumor, PNET), astrocytoma and ependymoma⁽⁸⁾.

Because of the presence of different operative approaches and treatment strategies for the posterior fossa neoplasms, accurate preoperative diagnosis became a very important goal in pediatric patients with cerebellar neoplasms⁽⁹⁾.

Conventional magnetic resonance imaging is the corner stone in the initial evaluation of pediatric

brain tumors. It detects the abnormal anatomical features of these tumors such as oedema, mass effect, calcification, cyst formation and abnormal distribution of the blood brain barrier by detecting post contrast enhancement⁽¹⁾.

Magnetic resonance imaging is the most commonly utilized technique for lesion detection, definition of extent, detection of spread and in evaluation of either residual or recurrent disease. There is basic principles and recent developments in MR technology pertinent to patients with brain neoplasms⁽¹⁶⁾.

The purpose of this study was to assess the role of MRI in differential diagnosis of infratentorial brain tumors in children by MRI.

2. Patients and Methods

The study included 30 patients with age ranging from 4 – 11 years with the mean age 7 years \pm 2SD. 17 patients (57 %) were males and 13 patients (43 %) were females .

All patients were selected according to their presentation with cranially related manifestations. All cases were subjected to full history, full clinical data and radiological examination by MRI.

The study was performed on 1.5 T MR unit (1.5 Tesla General Electric machine , USA) with a protocol that included axial and sagittal T1-Weighted spin echo (SE) sequences, axial and

coronal T2-Weighted fast SE (FSE) sequences. Fluid attenuated inversion (FLAIR) technique was performed also for patients in the axial plane using

Intravenous contrast medium was administered to all cases using Gd-DTPA, 0.1ml/ Kg, given manually by a slow intravenous injection. Post contrast FLAIR axial sequences were also performed.

Echo-planar diffusion-weighted images (DWI) were obtained in 19 patients and were acquired with b values of 1000 seconds/mm² in 3 orthogonal gradient directions. Apparent diffusion coefficient (ADC) images were also generated to assess false-positive non diffusion-related effects on DWI.

Reports from light microscopic studies were obtained by neuropathologist for all cases of our study.

3. Results

Thirty patients were diagnosed by MRI as infratentorial brain tumors which in turn were diagnosed as: cerebellar juvenile pilocytic astrocytoma in 10 patients (33%), medulloblastoma

in 10 patients (33%), infratentorial ependymoma in 4 patients (13%), brain stem glioma in 5 patients (17%) and atypical teratoid rhabdoid tumor only in one patient (3%).

The age group of medulloblastoma cases ranged from 4 to 10 years, the peak occurrence is 5-6 years, 7 males (70%) and 3 females (30%).

The medulloblastoma, on T1-weighted images, generally had low to intermediate signal. On T2-weighted, medulloblastomas generally had intermediate to moderately high signal (Fig 1). Signal heterogeneity on T2-weighted images was observed in 80% of the lesions (8 cases) and resulted from intratumoral cystic zones, small blood vessels, and/or calcifications. On T1-weighted images, the enhancement was extremely variable.

Cerebrospinal fluid seeding occurs in one patient which about 10% of cases of medulloblastoma. Therefore, when medulloblastoma is suspected, it is crucial to extend preoperative MRI to the spine as detection of spinal seeding may modify therapeutic strategies.

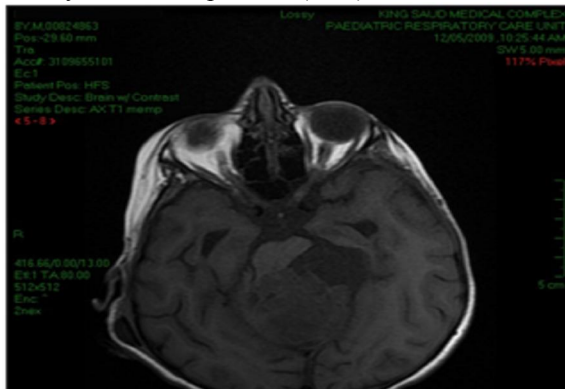
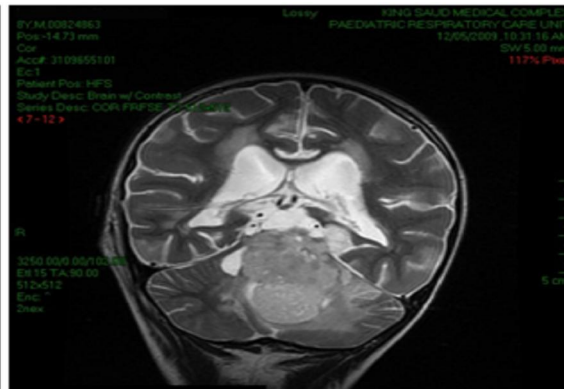


Fig (1-a)



Fig(1-b)

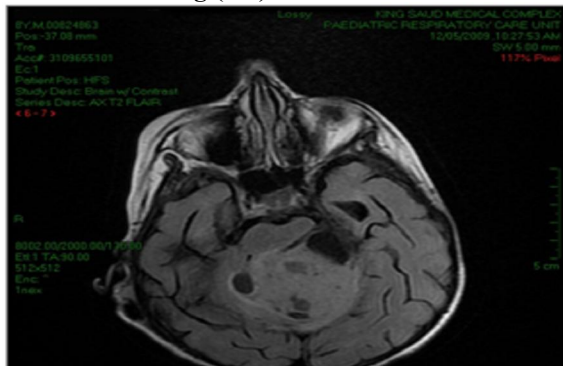


Fig (1-c)

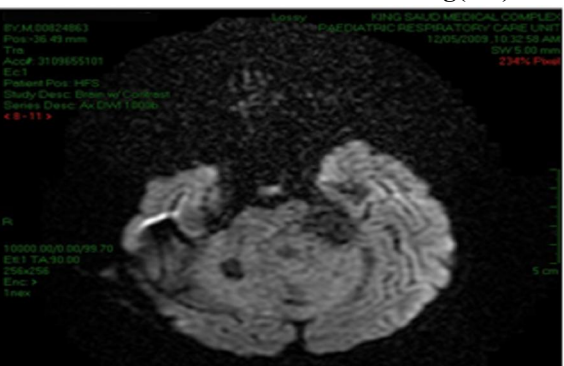


Fig (1-d)

Fig (1) Medulloblastoma: Male 8 years old with headache and vomiting. There was a well-defined posterior fossa midline lesion occupying the vermis compressing the 4th ventricle, medulla and brain stem. It was heterogeneous iso-intense on axial T1 WI (a), hyperintense on coronal T2 WI (b) and axial flair WI (c). The mass showed hyper intense signal intensity with central hypointense area in DWI restricted diffusion (d)

There were 10 case of juvenile pilocytic astrocytoma : 5 males (50%) and 5 females (50%) and the age ranged between 4 and 11 years old with a peak at 8 years. 6 cases at cerebellar vermis (60%) and 4 cases at cerebellar hemisphere (40%).

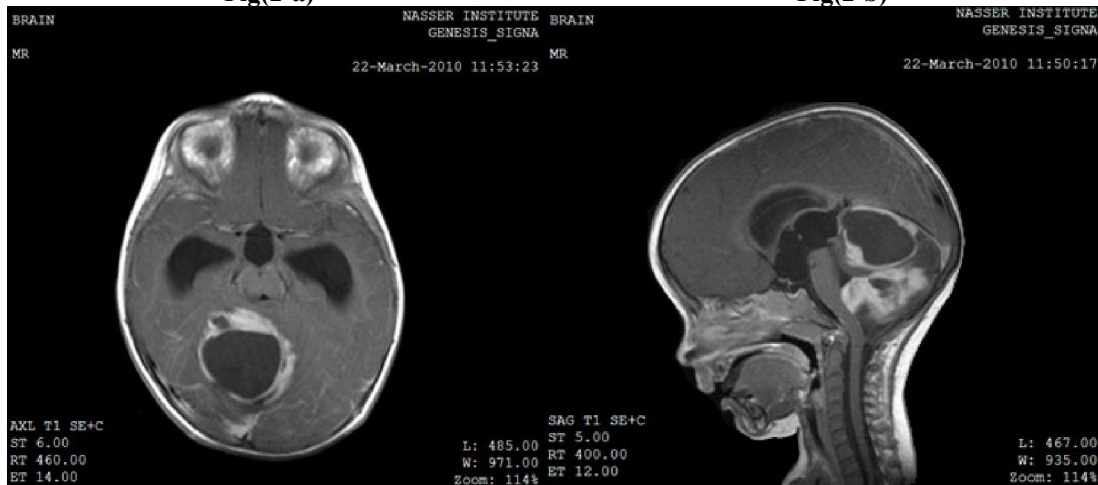
In astrocytoma, 60% (6 cases) of tumors are cystic with an enhancing mural nodule. 40% of cases (4 cases) of tumors are solid with cystic or necrotic centers. The solid tumors showed usually heterogeneous enhancement. Calcification was noted in one case 10 % (Fig 2).



Fig(2-a)



Fig(2-b)



Fig(2-c)

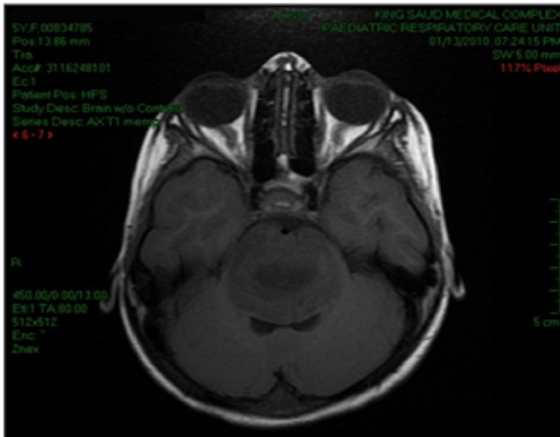
Fig(2-d)

Fig (2): Juvenile pilocytic astrocytoma, 4 years old female with torticollis since birth. Extensive, mostly cystic, partly solid infratentorial brain tumor with consecutive occlusion hydrocephalus and signs of intracranial pressure which is hypointense at T1 weighted image (a), and in T2 weighted sequences with signal intense tumor and perifocal edema intracerebellar (b) . T1 weighted axial image with contrast (c). Partly contrast enhancement in the solid areas and in the margins of the cysts also seen in T1 weighted image with contrast, sagittal view (d).

In our study, 5 cases were brain stem glioma which represented 17% of posterior fossa tumor. The patients were 2 males and 3 females, their ages ranged from 5 to 10 years.

The brain stem glioma have low signal intensity on T1WI in the pons with edema and expansion in most cases .The basilar artery is encased by the

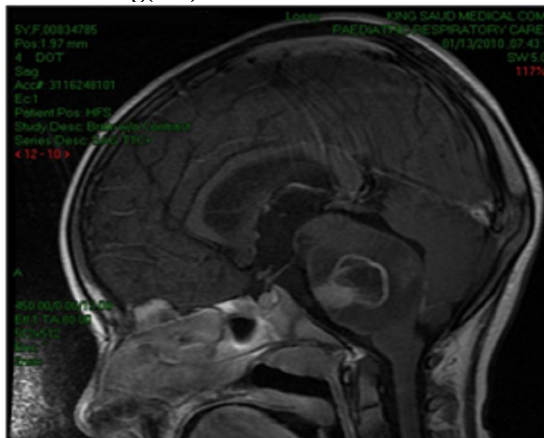
lesion (in 3 cases). The fourth ventricle is distorted. Contrast-enhanced T1-weighted image shows no appreciable enhancement in 3 cases and the rest enhanced minimally. DW image shows iso intensity of the lesion they have cystic degeneration in 3 cases (Fig 3).



Fig(3-a)



Fig(3-b)



Fig(3-c)



Fig(3-d)

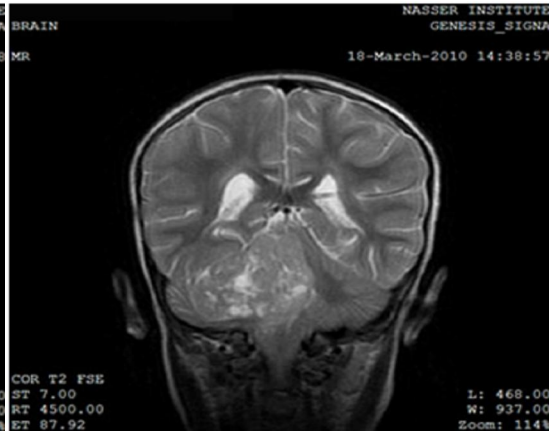
Fig (3): Brain stem glioma : female 5 years old with severe headache , with large pontine mass with significant mass effect on the adjacent brain stem structure and prepontine cistern and deforming the 4th ventricle inferiorly with mild hydrocephalus , low signal in axial T1WI (a), hyperintense in sagittal T2WI (b), it shows ring enhancement at the cystic structure with anterior peripheral solid portion enhancement in sagittal T1 WI with contrast (c). The mass showed isointense signal intensity with central hypointense area in DWI (d).

All 4 cases of infratentorial ependymomas (13 % of total cases, 2 males an 2 females, their age 6 to 11 year) are an intraventricular mass .They were seen as a heterogeneously hypointense mass on T1-weighted and an iso to hyperintense mass on T2-weighted images (Fig 4). Foci of high signal were seen representing necrotic or cystic

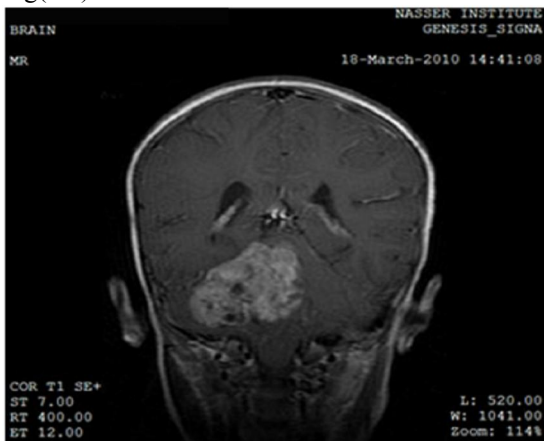
tissue and low-signal areas as calcification and hemorrhage. Heterogeneous enhancement was seen after gadolinium administration. Hydrocephalus presents in all cases. Other findings in 3 cases included an expanded fourth ventricle and spread of the tumor to the recesses of Luschka and the foramen of Magendi .



Fig(4-a)



Fig(4-b)



Fig(4-c)

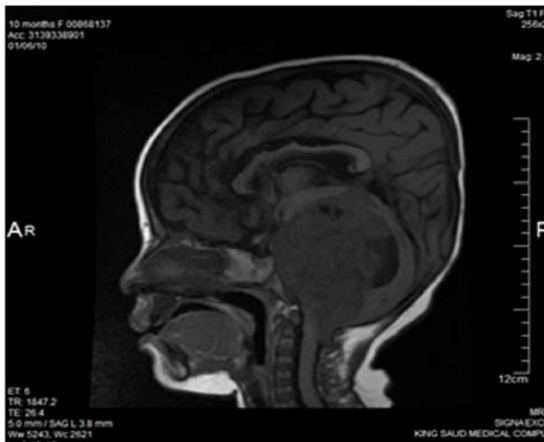


Fig(4-d)

Fig (4): Ependymoma , 9 years old female with severe headache . T1 axial (a) showed heterogeneous mass within fourth ventricle which was hypointense to cerebellar cortex. T2 coronal image (b) showed heterogeneous mass within fourth ventricle with multiple hyperintense areas. T1, coronal and sagittal post contrast images (c, d) showed heterogenous enhancement of the mass.

In this study there was one case of atypical teratoid rhabdoid tumour occurred in 4 year old child with seizures and appear as large infiltrative heterogeneous space occupying lesion involving

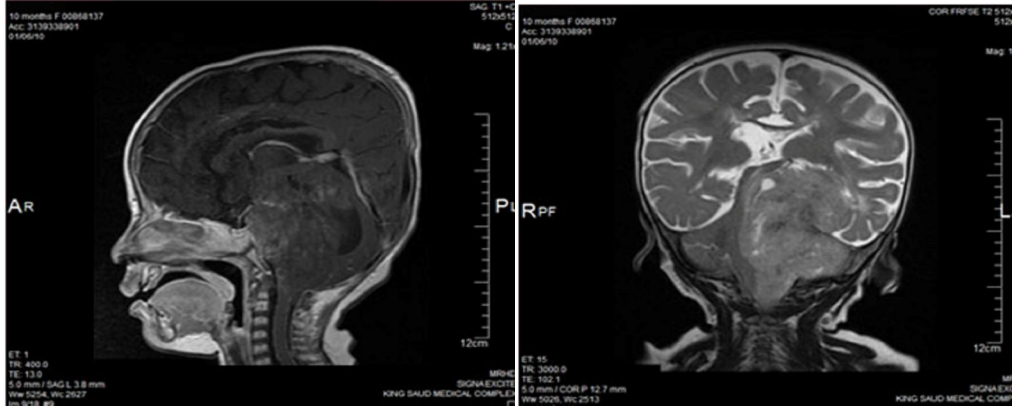
of posterior fossa, medulla, brain stem and left side of midbrain which hypo intense in T1WI and hyper intense in T2WI, (Fig 5).



Fig(5-a)



Fig(5-b)



Fig(5-c)

Fig(5-d)



Fig(5-e)

Fig (5): Atypical teratoid rhabdoid tumor, male patient 4 year with seizures. Large infiltrative heterogenous space occupying lesion involving posterior fossa, medulla, brain stem and left side of midbrain which appear slightly hypointense in sagittal FLAIR(a). This tumor was showing relatively heterogeneously hyperintense signal on T2 in axial T2 WI (b). It showed heterogenous enhancement in sagittal T1WI with contrast (d). The mass is extending higher up through tentorium in coronal T2 WI (d) pushing the left temporal lobe and temporal horn of left lateral ventricle and tumor extending down through the foramen magnum causing compression of the lower aspect of the medulla and upper aspect of cervical spinal cord and compression of 4th ventricle with hydrocephalus. DWI shows hyper signal intensity of the mass (e).

4. Discussion

MR imaging is widely used in the diagnosis and follow-up of pediatric patients with brain tumors because of its ability to provide anatomic detail. Although conventional MR imaging does not provide information about tissue biochemistry, it is important in the classification of tumors and degree of malignancy. MR contrast enhancement assists in defining tumor borders. The age group of the cases ranged from 4 to 11 years which go with Crist and Kun⁽⁵⁾ who found that children from 4 to 11 years of age have more infratentorial neoplasms than children under the age of 3 years.

The cases of astrocytomas were 60% (6 cases) cystic with an enhancing mural nodule and 40% (4 cases) of tumors are solid with cystic or necrotic centers with heterogeneous enhancement which is in line with Brian D et al., 2010.⁽³⁾

In the current study, the preoperative MR studies of 10 patients with surgically proved to be medulloblastomas. With the exception of one case (10%) all tumors arise at the midline cerebellar vermis and occupying the fourth ventricle to a variable degree and this is in agree with Mariana et al.⁽¹¹⁾ who found that the cerebellar vermis is the most common location for medulloblastomas (>75%). In this study cerebrospinal fluid seeding occurs in one patient which about 10% of cases of medulloblastoma. Therefore, when medulloblastoma is suspected, it is crucial to extend preoperative MRI to spine as detection of spinal seeding may modify therapeutic strategies, and this findings was also noted with Djamil F.⁽⁷⁾

One case of recurrent medulloblastoma after 2 years of operation and seen as focal parenchymal

nodular enhancement within the posterior fossa which against Yazigi et al⁽¹⁷⁾ study in 2008 who found that most recurrent medulloblastoma in children develops in the first 2 years after initial treatment. Four cases were diagnosed as ependymomas which represent about 13 % which go with Zacharoulis and Moreno⁽¹⁸⁾.

Signal heterogeneity is a feature useful in distinguishing ependymoma from the more homogeneous medulloblastoma. Calcification and hemorrhagic foci are more typical of ependymoma than medulloblastoma. Additionally, ependymomas are more able to extend through the foramina of Luschka and Magendie⁽¹⁵⁾.

In the current study, all 4 cases of ependymomas appeared as intraventricular mass. They were seen as a heterogeneous hypointense mass on T1-weighted and an iso to hypointense mass on T2-weighted images. Foci of high signal were seen representing necrotic or cystic tissue and low-signal areas as calcification and hemorrhage. Heterogeneous enhancement was seen after gadolinium administration. Hydrocephalus presented in all cases. Other findings in 3 cases included an expanded fourth ventricle and spread of tumor to recesses of Luschka and foramen of Magendie which go with Spoto et al.⁽¹⁵⁾ and Massimino et al.⁽¹²⁾

The five cases of brain stem glioma represented 17% of posterior fossa tumor in this study and went with Dimitri R et al 2010⁽⁶⁾. All cases have low signal on T1WI - of lesion in the pons with pons edema and expansion in most cases. The basilar artery was encased by the lesion (in 3 cases). The fourth ventricle was distorted. Contrast-enhanced T1-weighted image showed no appreciable enhancement in 3 cases and the rest enhanced minimally. DW image showed isointensity of the lesion they have cystic degeneration in 3 cases.

In this study there was one case of atypical teratoid rhabdoid tumor which occur in 4 year old child with seizures and appeared as a large infiltrative heterogenous space occupying lesion involving the posterior fossa, medulla, brain stem and left side of midbrain which is hypointense in T1WI and hyperintense in T2WI and these findings were in accordance to Packer et al.⁽¹³⁾

Conclusion

Magnetic resonance imaging (MRI) is the primary imaging modality used for the assessment of intracranial tumors as MRI provides superior delineation of the extent of tumor due to its greater soft tissue contrast, multiplanar imaging capability, and it is the diagnostic modality of choice in the

workup and follow-up observation of intracranial neoplasms. MRI better characterizes CNS tumors, and findings often lead to a presumptive diagnosis.

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