Role of Diffusion MRI in Differentiation between the Common Pediatric Posterior Fossa Brain Tumors

Thesis

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أعوذ بالله من الشيطان الرجيم

بسم الله الرحمن الرحيم

قَالُوا۟ سُبْحَٰنَكَ لَا عِلْمَ لَنَآ
إِلَّا مَا عَلَّمْتَنَآ ۖ إِنَّكَ أَنتَ ٱلْعَلِيمُ ٱلْحَكِيمُ

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Osama Mohamed Abobakr Khattab

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List of Abbreviations

Abbr.		Full-term
ADC	**:**	Apparent Diffusion Coefficient
AICA	**:**	Anterior inferior cerebellar artery
ASA	**:**	Anterior spinal artery
ATRT	**:**	Atypical rhabdoid/teratoid tumor
CN	**:**	Cranial nerve
CNS	**:**	Central nervous system
CPP	**:**	Choroid plexus papilloma
CSF	**:**	Cerebrospinal fluid
DIPG	**:**	Diffuse intrinsic pontine glioma
DN	**:**	Desmoplastic nodular
DTPA	**:**	Diethylene triamine penta-acetic acid
DWI	**:**	Diffusion weighted Image
EGFR	**:**	Epidermal growth factor receptor
EN	**:**	extensive nodularity
EPN	**:**	Ependymoma
F	**:**	Female
GBM	**:**	Glioblastoma
Gd	**:**	Gadolinium
gFAP	**:**	Glial Fibrillary Acid Protein
HB	**:**	Hemangioblastoma
HS	**:**	Highly significant
ICP	**:**	Inferior cerebellar peduncle
IDH	**:**	Isocitrate dehydrogenase

JPA	**:**	Juvenile pilocytic astrocytoma
LCA	**:**	Large cell anaplastic
M	**:**	Male
MB	**:**	Medulloblastoma
MCP	**:**	Middle cerebellar peduncle
MRI	**:**	Magnetic resonance imaging
NF1	**:**	Neurofibromatosis Type 1
NF2	**:**	Neurofibromatosis Type 2
NOS	**:**	Not otherwise specified
NS	**:**	Not significant
PCA	**:**	Posterior cerebral arteries
PICA	**:**	Posterior inferior cerebellar artery
PNET	**:**	Primitive neuroectodermal tumor
PSA	**:**	Posterior spinal artery
ROI	**:**	Region of interest
S	**:**	Significant
SCA	**:**	Superior cerebellar artery
SCP	**:**	Superior cerebellar peduncle
SE	**:**	Spin-echo
VHL	**:**	Von Hippel-Lindau disease
WHO	**:**	World Health Organization
WI	**:**	Weighted Image

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Abstract

Background: Diffusion weighted imaging (DWI) and apparent diffusion coefficient (ADC) map provide information on MRI about the cellularity of the tumor and have an important role in the pre-operative differentiation of different tumor types.

Objective: The aim of this work is to assess the role of diffusion MRI in differentiation between the most frequently encountered pediatric posterior fossa brain tumors.

Materials and methods: Twenty-four patients were prospectively included in this study. They were referred from the Neurosurgery Department. All of them were suspected to have posterior fossa SOL according to the contrast enhanced CT. All patients were subjected to conventional MRI followed by diffusion MR imaging and calculation of the ADC values.

Results: Twenty-four children (15 females) were included in the study. Their ages ranged between one and fifteen years old with a mean age of six years. Low-and high-grade tumors could be differentiated by using both absolute ADC values and ratios. Low-grade tumors showed statistically significantly higher ADC values (1.69±0.15 vs. 0.80±0.23) and ratios for tumor versus normal cerebellum (2.17±0.30 vs. 1.14±0.33) and tumor versus brain stem (1.88±0.35 vs. 1.06±0.24).The probability of error at 0.05 was considered significant, while at 0.01 and 0.001 was considered highly significant. Absolute ADC values and cerebellar and brainstem ratios were significantly higher in low-grade astrocytomas than in MBs. Overlap was found between ADC values of ATRTs and MBs. The sensitivity and specificity of a cutoff ADC value of $> 1.083 \times 10^{-3} mm^2/s$ for differentiation of pilocytic astrocytomas from MBs and ependymomas were 100%.The sensitivity and specificity of a cutoff ADC value of $\leq 0.847 \times 10^{-3} mm^2/s$ for differentiation of medulloblastomas from PAs and ependymomas were 100%.The sensitivity and specificity of a cutoff ADC value of $\leq 1.083 \times 10^{-3} mm^2/s$ and $> 0.847 \times 10^{-3} mm^2/s$ for ependymomas were 100%.

Conclusion: The calculation of ADC value in the solid enhancing portion of a tumor is a simple and reliable technique for preoperative differentiation of the most common posterior fossa tumors.

Keywords:DWI,ADC,Posterior fossa tumors.

Introduction

Brain tumors are the most common solid tumors in childhood and the second most common neoplasm in childhood after hematological malignancies; however they are the leading cause of morbidity and mortality. Up to 60-70% of brain tumors are infra tentorial, being most common in children from 4 to 11 years ***(Poretti and Meoded, 2012)*****.**

Common posterior fossa brain tumors in children include juvenile pilocytic astrocytoma (JPA), medulloblastoma (MB), ependymoma and brainstem gliomas. Because these various tumors require very different treatment approaches and have significantly different natural histories and outcomes, an accurate and specific diagnosis is mandatory ***(Poretti and Meoded, 2012)***.

Histopathological evaluation of brain biopsies is still the gold standard for definitive diagnosis. However there are also limitations to histological diagnosis, *e.g.* sampling errors in surgical biopsies due to intrinsic tissue heterogeneity where tumor under grading can occur and also due to the complication of being invasive. So the development of new non-invasive diagnostic tools is necessary.

Though computed tomography is widely available, its disadvantages include radiation exposure, inferior soft tissue resolution when compared to MRI and the risk associated with injection of iodinated contrast medium ***(Haaga and Boll, 2008).***

In comparison, MRI with its superior tissue resolution and the fact that it's radiation free is considered the most suitable imaging modality for initial diagnosis. Conventional MR imaging incorporating contrast-enhanced T1-weighted and T2-weighted sequences helps to characterize the location and extent of these tumors, however MR imaging provides limited information regarding tumor type and grade. Consequently, conventional MR imaging falls short as a definitive diagnostic examination ***(Gauvain et al., 2006).***

Diffusion MR imaging is a technique in which dedicated phase-defocusing and -refocusing gradients allow evaluation of microscopic water diffusion within tissues and has been considered a means to characterize and differentiate morphologic features, including edema, necrosis, and tumor tissue, by measuring differences in apparent diffusion coefficient (ADC) caused by water proton mobility alterations. Recent studies evaluated the role of diffusion weighted imaging (DWI) in differentiating type and grade of pediatric brain tumors in the posterior fossa with promising results ***(Jones, 2011).***