Medulloblastoma Magnetic Resonance Imaging

T1

T1WI → hypo- to isointense.

Generally hypointense to grey matter

T1 C+ (Gd)

overall 90% enhance, often heterogeneously Medulloblastoma, WNT-activated tend to vividly enhance [1)]

Group 4 medulloblastoma tend to enhance less [2)]

Tumor location and enhancement pattern were predictive of molecular subgroups of pediatric medulloblastoma and may potentially serve as a surrogate for genomic testing [3)].

Enhancing medulloblastomas exhibited strong VEGFR1/2 and CD31 expression relative to nonenhancing tumors. There was no significant difference in perioperative complications or patient survival between the 2 groups.

These results suggest that in patients with medulloblastoma the presence of enhancement on MRI may correlate with increased vascularity and angiogenesis, but does not correlate with worse patient prognosis in the short or long term [4)].

T2

overall are iso to hyperintense to grey matter

heterogeneous due to calcification, necrosis, and cyst formation

surrounding edema is common [5)]

T2 weighted image → heterogeneous due to tumor cysts, vessels, and calcifications [6)]

DWI

high DWI signal (“restricted diffusion”).

Proton magnetic resonance spectroscopic imaging

elevated choline

decreased NAA.

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group 3 or 4

taurine peak

high creatine

SHH

little or no taurine

low creatine.

Apparent diffusion coefficient

Low ADC values (lower than normal cerebellum e.g. ~550 x 10-6 mm2/s) [7].

Using only apparent diffusion coefficient (ADC) values measured on ADC maps. One hundred and three pediatric patients with pre-operative magnetic resonance imaging scans showing a posterior fossa tumor with histological verification were retrospectively identified from a ten-year period at a tertiary care medical center. A single observer measured the lowest ADC values in all tumors to determine the mean minimum ADC (ADCmin) value that provided greatest accuracy in distinguishing medulloblastomas from other tumors, which was determined to be 0.66×10(-3) mm(2)/s. Imaging studies, including ADC maps, from 90 patients were provided to two neuroradiologists, who provided a diagnosis, which was later dichotomized as medulloblastoma or other. Two medical students measured ADCmin within tumors and those with ADCmin < 0.66×10(-3) mm(2)/s were recorded as medulloblastoma; any other value was recorded as other. Diagnostic accuracy was measured. ADCmin values allowed a correct identification of lesions as either medulloblastoma or other in 91% of cases. After diagnoses by the two neuroradiologists were categorized as either medulloblastoma or other, their diagnoses were correct in 90% and 84% of cases, respectively. In 19 cases, at least one

neuroradiologist was incorrect; the addition of ADC values to clinical interpretation would have allowed a correct diagnosis in 63% of such cases. Diagnostic accuracy based on ADC values by medical students was comparable to that of subspecialty-trained neuroradiologists. This findings suggest that the addition of ADC values to standard film interpretation may improve the diagnostic rate for these tumors [8].

Both ADCmin and nADC could serve as the basis for a CAD program to distinguish medulloblastoma from other posterior fossa tumors with a high degree of accuracy [9].

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94 cases, of which 75 were diagnosed cases of ependymoma, medulloblastoma, brainstem glioma, and pilocytic astrocytoma and 19 were normal MRI brain cases. The data was randomized into training data, 64 cases; test data, 21 cases and validation data, 9 cases to devise a deep learning algorithm to segment the pediatric brain tumor. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of the deep learning model were compared with the radiologist's findings. Performance evaluation of AS was done based on Dice score and Hausdorff95 distance.

Analysis of MRI semantic features was done with necrosis and hemorrhage as predicting features for ependymoma, diffusion restriction, and cystic changes were predictors for medulloblastoma. The accuracy of detecting abnormalities was 90%, with a specificity of 100%. Further segmentation of the tumor into enhancing and non-enhancing components was done. The segmentation results for whole tumor (WT), enhancing tumor (ET), and non-enhancing tumor (NET) have been analyzed by Dice score and Hausdorff95 distance. The accuracy of the prediction of all MRI features was compared with experienced radiologist's findings. Substantial agreement was observed between the classification by model and the radiologist's given classification [K-0.695 (K is Cohen's kappa score for interrater reliability)].

The deep learning model had very high accuracy and specificity for predicting the magnetic resonance (MR) characteristics and close to 80% accuracy in predicting tumor type. This model can serve as a potential tool to make a timely and accurate diagnosis for radiologists not trained in neuroradiology [10]

Spinal imaging

As CSF seeding is common at presentation, imaging with the contrast of the whole neuraxis is recommended to identify drop metastases and leptomeningeal spread. Although rare, the extraneural spread is reported.

MRI with IV gadolinium or CT/myelography with water-soluble contrast should be done to rule out “drop metastases.” Staging is done either pre-op or within 2–3 weeks of surgery.

1)
Ellison DW, Korshunov A, Northcott PA, Taylor MD, Kaur K, Clifford SC, Medulloblastoma. In: WHO Classification of Tumours Editorial Board. Central nervous system tumours. Lyon (France): International Agency for Research on Cancer; 2021. (WHO classification of tumours series, 5th ed.; vol. 6). https://publications.iarc.fr/601
2) , 5)

Perreault S, Ramaswamy V, Achrol AS, Chao K, Liu TT, Shih D, Remke M, Schubert S, Bouffet E, Fisher PG, Partap S, Vogel H, Taylor MD, Cho YJ, Yeom KW. MRI surrogates for molecular subgroups of medulloblastoma. AJNR Am J Neuroradiol. 2014 Jul;35(7):1263-9. doi: 10.3174/ajnr.A3990. Epub 2014 May 15. PMID: 24831600; PMCID: PMC4819007.
3)

Perreault S, Ramaswamy V, Achrol AS, Chao K, Liu TT, Shih D, Remke M, Schubert S, Bouffet E, Fisher PG, Partap S, Vogel H, Taylor MD, Cho YJ, Yeom KW. MRI Surrogates for Molecular Subgroups of Medulloblastoma. AJNR Am J Neuroradiol. 2014 May 15. [Epub ahead of print] PubMed PMID: 24831600.
4)

Hervey-Jumper SL, Garton HJ, Lau D, Altshuler D, Quint DJ, Robertson PL, Muraszko KM, Maher CO. Differences in vascular endothelial growth factor receptor expression and correlation with the degree of enhancement in medulloblastoma. J Neurosurg Pediatr. 2014 Jun 6:1-8. [Epub ahead of print] PubMed PMID: 24905841.
6)

Blaser SI, Harwood-Nash DC. Neuroradiology of pediatric posterior fossa medulloblastoma. J Neurooncol. 1996; 29:23–34
7)

Pierce T & Provenzale J. Evaluation of Apparent Diffusion Coefficient Thresholds for Diagnosis of Medulloblastoma Using Diffusion-Weighted Imaging. Neuroradiol J. 2014;27(1):63-74. doi:10.15274/nrj-2014-10007
8)

Pierce T, Kranz PG, Roth C, Leong D, Wei P, Provenzale JM. Use of apparent diffusion coefficient values for diagnosis of pediatric posterior fossa tumors. Neuroradiol J. 2014 Apr;27(2):233-44. doi: 10.15274/NRJ-2014-10027. Epub 2014 Apr 18. PubMed PMID: 24750714.
9)

Pierce TT, Provenzale JM. Evaluation of apparent diffusion coefficient thresholds for diagnosis of medulloblastoma using diffusion-weighted imaging. Neuroradiol J. 2014 Feb;27(1):63-74. Epub 2014 Feb 24. PubMed PMID: 24571835.
10)

Mahajan A, Burrewar M, Agarwal U, Kss B, Mlv A, Guha A, Sahu A, Choudhari A, Pawar V, Punia V, Epari S, Sahay A, Gupta T, Chinnaswamy G, Shetty P, Moiyadi A. Deep learning based clinico-radiological model for paediatric brain tumor detection and subtype prediction. Explor Target Antitumor Ther. 2023;4(4):669-684. doi: 10.37349/etat.2023.00159. Epub 2023 Aug 30. PMID: 37720352; PMCID: PMC10501890.