Prediction of H3K27M Alteration Status in Brainstem Glioma Using Multi-Shell Diffusion MRI Metrics

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Abstract

Background: Multi-shell diffusion characteristics may help characterize brainstem gliomas (BSGs) and predict H3K27M status.

Purpose: To identify the diffusion characteristics of BSG patients and investigate the predictive values of various diffusion metrics for H3K27M status in BSG.

Study type: Prospective.

Population: Eighty-four BSG patients (median age 10.5 years [IQR 6.8-30.0 years]) were included, of whom 56 were pediatric and 28 were adult patients.

Field strength/sequence: 3 T, multi-shell diffusion imaging.

Assessment: Diffusion kurtosis imaging and neurite orientation dispersion and density imaging analyses were performed. Age, gender, and diffusion metrics, including fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity, radial diffusivity (RD), mean kurtosis (MK), axial kurtosis (AK), radial kurtosis, intracellular volume fraction (ICVF), orientation dispersion index, and isotropic volume fraction (ISOVF), were compared between H3K27M-altered and wildtype BSG patients.

Statistical tests: Chi-square test, Mann-Whitney U test, multivariate analysis of variance (MANOVA), step-wise multivariable logistic regression. P-values <0.05 were considered significant.

Results: 82.4% pediatric and 57.1% adult patients carried H3K27M alteration. In the whole group, the H3K27M-altered BSGs demonstrated higher FA, AK and lower RD, ISOVF. The combination of age and median ISOVF showed fair performance for H3K27M prediction (AUC = 0.78). In the pediatric group, H3K27M-altered BSGs showed higher FA, AK, MK, ICVF and lower RD, MD, ISOVF. The combinations of median ISOVF, 5th percentile of FA, median MK and median MD showed excellent predictive power (AUC = 0.91). In the adult group, H3K27M-altered BSGs showed higher ICVF and lower RD, MD. The 75th percentile of RD demonstrated fair performance for H3K27M status prediction (AUC = 0.75).

Data conclusion: Different alteration patterns of diffusion measures were identified between H3K27M-altered and wildtype BSGs, which collectively had fair to excellent predictive value for H3K27M alteration status, especially in pediatric patients.

Evidence level: 2 TECHNICAL EFFICACY: Stage 3.

Keywords: H3K27M alteration; brainstem glioma; diffusion kurtosis imaging; multi-shell diffusion; neurite orientation dispersion and density imaging.

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