Using Histogram Analysis of Diffusion-Tensor Imaging Metrics to Predict Meningioma Grade and Consistency

Robert L. Bailey MD; Sumei Wang; Peter Syre MD; Marie Kerr CCRP; Donald M. O'Rourke MD; John Y.K. Lee MD

Department of Neurosugery, Department of Radiology, Division of Neuroradiolgy; University of Pennsylvania, Philadelphia, Pennsylvania

Introduction

Prediction of tumor grade and consistency prior to operative intervention is a valuable objective. Diffusion tensor (DT) magnetic resonance (MR) imaging is a promising tool for detecting a microscopic difference in tissue properties. The purpose of our study is to ascertain whether histogram analysis of DT imaging metrics can help determine the grade and consistency of meningiomas.

Methods

We have previously reported a retrospective series of nine atypical, three anaplastic and 39 typical meningiomas. Various DT imaging metrics were utilized to determine the best model for subtype classification. Based on the success of that effort, we created a prospective study to correlate MR findings with actual tumor characteristics. Surgeons have been asked to grade tumor consistency and vascularity on a 7-point scale. In addition, tumor specimens have been stained to measure collagen content. These measures were then correlated with the preoperative DT imaging characteristics. Preliminary data has been obtained from four patients thus far, and study candidates continue to be enrolled.

Results

Our retrospective data demonstrated that histogram skewness of eigenvalue skewness (SK) and kurtosis of SK were significantly higher in atypical and anaplastic meningiomas than in typical meningiomas (P < .01). Among typical meningiomas, significant differences in histogram measures of planar anisotropy coefficient (CP) and spherical anisotropy coefficient (CS) between fibroblastic meningiomas and other subtypes were observed (P < .01). The prospective data is in its preliminary stage, but early results appear to support the findings of the retrospective series.

Conclusions

Histogram analysis of DT MR imaging may be able to determine histologic grade and subtype of meningiomas prior to surgery. If this imaging analysis can demonstrate high sensitivity and specificity, it may be an extremely valuable adjunct to surgical planning and improve patient outcomes.