

## Diffusion Tensor Imaging Reveals Disease-Specific Dentate Nucleus Changes in Cerebellar Degeneration

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### Introduction

Cerebellar degeneration is characterized by progressive impairment of gait, speech, motor coordination, and eye movements. Although atrophy of the cerebellar cortex is considered a key sign, interpretation of cerebellar magnetic resonance imaging (MRI) may be confounded by age-related atrophy and poor visualization of posterior fossa structures. Direct quantification of cerebellar cortical volume on high resolution MRI is not only a time-consuming process, but also may be confounded by complex cerebellar foliation, which introduces partial volume effects. The deep cerebellar nuclei (which, including the vestibular nuclei, mediate virtually all cerebellar outflow) may provide a better index for disease, as they frequently show histopathological involvement. However, published methods for volumetric assessment on MRI are not reliable in all ages and disease states. (1,2) Our team has recently developed techniques for delineation of the deep cerebellar nuclei using diffusion tensor imaging (DTI). Thus, we asked whether DTI evaluation of the dentate nucleus (largest of the deep cerebellar nuclei) would reveal evidence of cerebellar disease.

### Methods

27 patients (16M/11F) with cerebellar disease and 19 controls (6M/13F) were studied. A multi-slice, single-shot EPI sequence achieved whole brain coverage (0.828x0.828x2.2 mm reconstructed, 32 diffusion directions, 3 acquisitions) on a 3T MR scanner (Intera, Philips Medical Systems). Neurological function was quantitatively assessed using the International Cooperative Ataxia Rating Scale(3) and subsections of the Unified Ataxic Disorders Rating Scale.

Bilateral dentate nuclei were manually delineated for all subjects. Mean fractional anisotropy (FA), mean diffusivity (MD), and normalized minimally weighted B0 intensity (T2w) contrasts were computed within the dentate for each subject. The group dependence of dentate volumes and mean contrasts were evaluated with a general linear framework controlling for age and sex. Dentate volumes were also compared with orthogonal cross-sections of the cerebellar peduncles, which were previously shown to correlate with cerebellar disease.(4,5)

### Results and Discussion

Dentate nucleus volume was decreased (mean decrease 357 mm<sup>3</sup>, P<0.01) in patients with cerebellar degeneration. Dentate volume also showed a trend toward a positive correlation with the superior cerebellar peduncle (SCP) orthogonal cross section but not with the other peduncle cross sections. This is consistent with the role of the SCP as the major outflow tract of the dentate nucleus. Although T2w, FA, and MD contrasts all correlated with dentate volume, these correlations may be

explained by changes in surface to volume ratios associated with degeneration. Analysis of all subjects showed positive correlation between the dentate volume and total ataxia score ( $P < 0.05$ ). The subscores that did not correlate with the dentate volume assessed those functions associated with vermal, bulbar, or peripheral systems, i.e. regions outside the purview of the dentate nucleus. Thus, DTI assessment of the dentate nucleus may indeed be an alternate, simple marker of cerebellar degeneration.

### References

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**Category:** *Disorders of the Nervous System*

**Sub-Category:** *Parkinson's disease and other basal ganglia*