Free Water Differences in the Cerebellum and Basal Ganglia of Essential Tremor Patients

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Introduction

Essential tremor (ET) is a neurological disorder that causes a rhythmic shaking that predominantly affects upper extremities[1]. Degeneration of certain areas of the cerebellum and basal ganglia is thought to play a vital role in the progression of ET since many of these brain regions are primarily involved in motor control[2]. Free water (FW) is the measure of extracellular volume (ECV). Excessive ECV is indicative of neuroinflammation, which is analogous to deterioration[3].

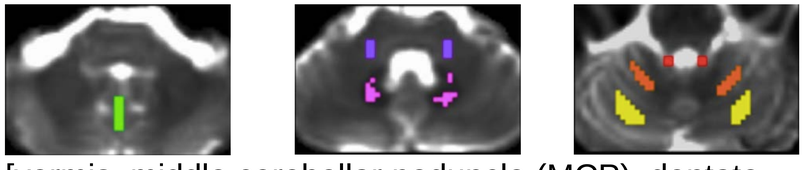
Methods

We recruited 24 ET patients ($\bar{x}$ = 64.5, s = 11.4) and 24 healthy controls ($\bar{x}$ = 64.8, s = 10.6). Diffusion magnetic resonance imaging (dMRI) at 3 Tesla was used to map out the movement of water in the brain.

Voxel-Based Morphometry

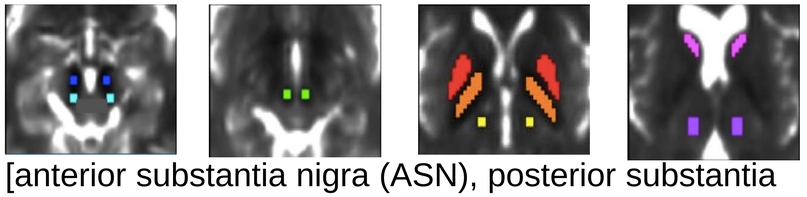
Using AFNI (a program for the analysis of functional neuroimages), we outlined regions of the cerebellum and basal ganglia in each participant's brain (labeled from left to right between images and top to bottom within images).

Cerebellum



[vermis, middle cerebellar peduncle (MCP), dentate, superior cerebellar peduncle (SCP), lobule V, lobule VI]

Basal Ganglia



[anterior substantia nigra (ASN), posterior substantia nigra (PSN), red nucleus (RN), putamen, globus pallidus (GP), subthalamis nucleus (STN), caudate nucleus (CN), thalamus (THA)]

Statistics

To determine whether the values between groups were significantly different, we used a multivariate analysis of variance with age as covariate (α = 0.05).

Results

When the free water values between ET patients and healthy controls were compared, two structures yielded significant results.

In the cerebellum, the middle cerebellar peduncle ($p < 0.01$) was different between ET patients and controls.

In the basal ganglia, the anterior substantia nigra ($p < 0.01$) and thalamus ($p < 0.01$) were different between ET patients and controls.

Figure 1

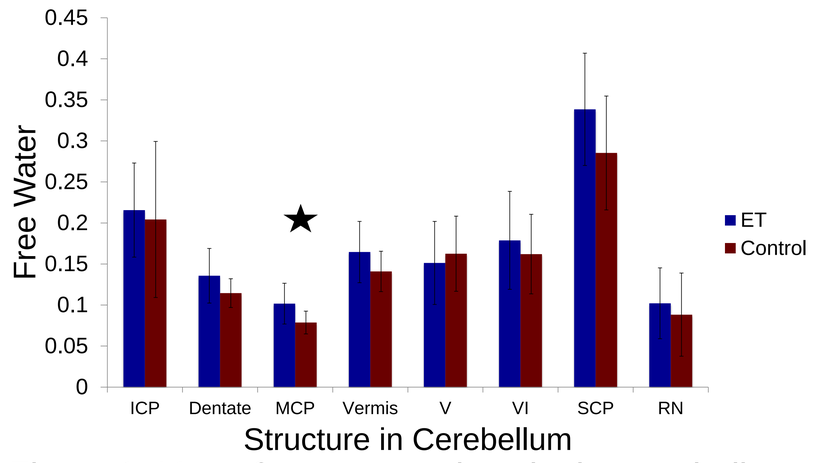


Figure 1: Mean free water values in the cerebellum between ET patients and healthy controls; error bars are +1 standard deviation.

Figure 2

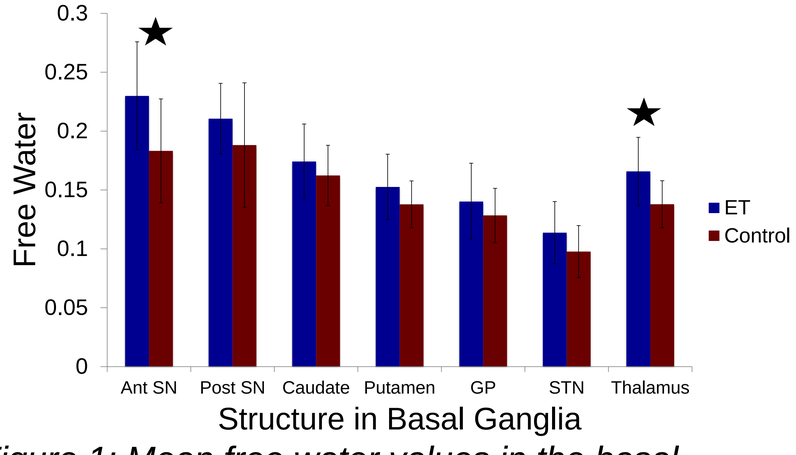


Figure 1: Mean free water values in the basal ganglia between ET patients and healthy controls; error bars are +1 standard deviation.

Conclusion

There is a clear indication that certain regions of the cerebellum and basal ganglia of essential tremor patients harbor more free water than those same regions in healthy controls. As is expected, regions of the brain that are responsible motor planning and voluntary movement show significantly more signs of deterioration in essential tremor than in healthy controls. While the preliminary findings of this study have not yet been utilized for practical applications, this information on where deterioration occurs in the brains of essential tremor patients can be utilized in later experiments by researchers who aim to develop drugs that may target these degenerated regions specifically.

Acknowledgments

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Literature Cited

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