

Impaired saccade adaptation: Result of distortion in cerebellar output

Palak Gupta^{1,2}, Abhimanyu Mahajan³, Jonathan Jacobs², Alberto Espay³, Aasef Shaikh^{1,2}

¹Department of Biomedical Engineering, Case Western Reserve University

²Daroff-Dell'Osso Ocular Motility Laboratory, Louis Stokes Cleveland VA Medical Center

³Department of Neurology, University of Cincinnati

Objective: To investigate the role of the cerebellum in pathophysiology of motor learning in Cervical Dystonia.

Background: Three million people worldwide suffer from dystonia and there are only a few effective treatments for dystonia because of poorly understood pathogenesis. Traditional hypothesis for Cervical Dystonia (CD) has focused on the basal ganglia, while CD has been found in patients with cerebellar lesions. We hypothesized that patients with ataxia predominant form of CD would lack the ability to adaptively modulate their saccade amplitude in motor adaptation tasks although their eye movements were clinically normal.

Methods: The study comprised of 12 patients with ataxia predominant CD and 3 healthy controls. The experiments were performed when the subjects were experiencing maximal therapeutic benefit with botulinum toxin and tremor pharmacotherapy. The horizontal and vertical eye positions were recorded with high-resolution video oculography technique at 500 Hz with an angular resolution of 0.1°. The eye positions were calibrated in vivo, prior to initiation of the experiment. We performed two experiments: a) open-loop trials to set the baseline i.e to assess changes in saccade gain as an index of level of saccade adaptation, b) motor adaptation trials which consisted of right and left double-step saccade adaptation experiments. These two experiments allowed us to analyze motor learning over slow and fast time scales, which was done by i) evaluating kinematic parameters of primary saccades - amplitude, peak velocity, acceleration and deceleration, ii) timing parameters - latency, duration, time to peak- velocity, acceleration, and deceleration.

Results: The results showed that in all 12 patients there was impaired saccadic adaptation over both time scales, no retention over slow time scales and minimal learning over the fast time scales.

Conclusion: These results seem to suggest that distorted cerebellar output is a pathophysiologic mechanism behind CD and not the lack of cerebellar activity as previously thought.