

Deep Brain Stimulation for Post-Traumatic Cerebellar Ataxia and Anterograde Amnesia: Multitarget Approach with 6 Electrodes, Electrophysiological and Tractographic Validation

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Abstract

Introduction: Post-traumatic cerebellar syndromes and memory disorders are highly disabling and refractory to conventional therapy. Deep brain stimulation (DBS) has shown therapeutic benefit in movement disorders, but its application in cerebellar and limbic circuits remains experimental. We report a pioneering case combining bilateral ventral intermediate nucleus (VIM) and Dentate nucleus (DN) stimulation for severe cerebellar ataxia and fornix stimulation for anterograde amnesia secondary to traumatic brain injury (TBI), supported by intraoperative electrophysiology. **Clinical description:** A 32-year-old male with severe TBI developed refractory pancerebellar syndrome (intention tremor, dysmetria, gait ataxia) and profound anterograde amnesia. MRI showed cerebellar and brainstem atrophy, hippocampal shrinkage, and thalamic involvement. DBS was proposed targeting the dentate nucleus bilaterally and the fornix. Microelectrode recordings in the VIM revealed multiple tremor cells with rhythmic bursting and low-frequency local field potentials (LFPs), confirming pathological oscillatory activity. Postoperative programming achieved marked reduction in tremor amplitude and improved motor coordination. Memory deficits persisted but showed mild improvement in short-term recall.

Discussion: VIM trajectory was deliberately planned at a deeper level to engage the dendrorubrothalamic tract (DRETT) 3, a major cerebellothalamic pathway implicated in tremor generation. This approach aimed to modulate pathological oscillatory activity transmitted from the dentate nucleus through the red nucleus to the thalamus, optimizing tremor control. Dentate stimulation has shown variable success in ataxia, while fornix stimulation is primarily described in Alzheimer's disease. Our findings suggest potential synergy, though cognitive recovery remains limited. Literature on combined approaches is scarce, underscoring the need for controlled trials.

Conclusions: This case demonstrates the feasibility of combining cerebellar and limbic DBS targets for complex post-traumatic syndromes. DBS targeting DN, DRETT and fornix may offer benefit in refractory cerebellar ataxia with coexisting memory impairment after TBI. Intraoperative microrecording and LFP analysis provide valuable biomarkers for optimizing targeting and programming.

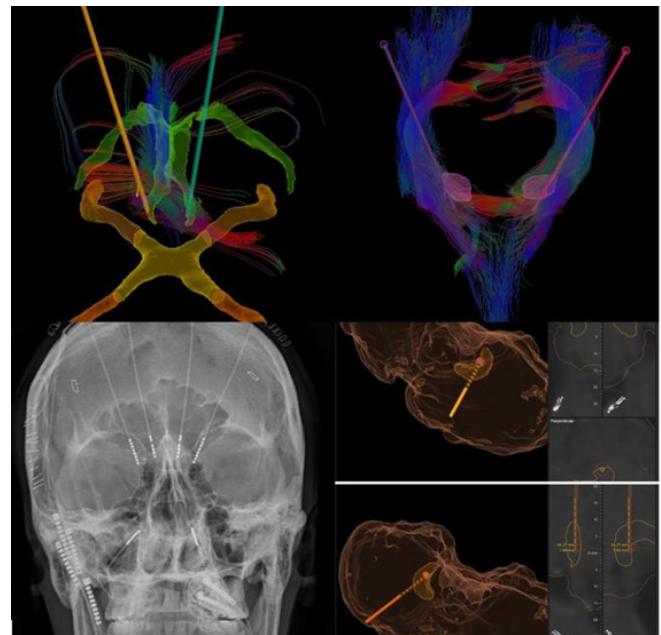


Figure 1. Multimodal reconstruction of multitarget deep brain stimulation (DBS) for combined ataxia and amnesia, integrating preoperative tractography and postoperative imaging. The trajectories show bilateral electrodes targeting the dentate nucleus, fornix, and dentato-rubro-thalamic tract (DRTT)/ventral intermediate nucleus (VIM). Diffusion tensor imaging (DTI) demonstrates the anatomical relationship between the implanted leads and cerebello-thalamo-cortical and limbic networks. Postoperative X-ray and 3D Brainlab Elements™ reconstructions confirm accurate stereotactic placement of six octopolar Boston Scientific™ electrodes, enabling modulation of motor coordination, memory circuits, and frontocerebellar connectivity within a unified neuromodulation framework.

References

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