# Thalamic centromedian nucleus deep brain stimulation

- Deep brain stimulation for refractory epilepsy: A meta-analysis of stimulation parameters
- Systematic Review and Meta-Analysis of Bilateral Centromedian Nucleus Neuromodulation for Multifocal and Generalized Epilepsy
- Refining centromedian nucleus stimulation for generalized epilepsy with targeting and mechanistic insights from intraoperative electrophysiology
- Dual bilateral stimulation of the nucleus accumbens and the centromedian thalamus for treatment of intractable Tourette syndrome
- Safety profile of intracranial neuromodulation for drug-resistant epilepsy in children
- Computational modeling of frequency-dependent neocortical response to thalamic neurostimulation in epilepsy
- Intracranial neuromodulation for pediatric drug-resistant epilepsy: early institutional experience
- Acute Disruption of Cortical Epileptiform Discharges With Thalamic Stimulation

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Thalamic centromedian nucleus deep brain stimulation (CM-DBS) is a neuromodulatory treatment targeting the centromedian (CM) nucleus of the thalamus, which is part of the intralaminar thalamic nuclei. This nucleus plays a key role in arousal, attention, and widespread cortical activation. DBS of this nucleus is used in several refractory neurological conditions, especially where network-level dysregulation is suspected.

## Main Indications for CM-DBS

1. Thalamic centromedian nucleus deep brain stimulation for Drug-resistant epilepsy

2. Tourette syndrome

In patients with severe, refractory tics where other medical and behavioral therapies have failed.

Targets both tic suppression and improvement in comorbid OCD/ADHD symptoms.

CM-DBS is one of the main targets along with anterior globus pallidus internus (GPi) and nucleus accumbens.

3. Disorders of consciousness (DOC)

Experimental use in minimally conscious states or vegetative states, especially traumatic in origin.

The rationale is to modulate arousal and attention networks.

Ethical and efficacy considerations limit its widespread use, but some case reports and pilot studies suggest benefit.

Other Investigational Indications:

These are less established but under study:

Chronic pain syndromes (central pain, post-stroke pain).

Parkinson's disease: CM-DBS not typically first-line, but may be considered in specific cases with axial symptoms or bradyphrenia.

Depression or OCD: rare off-label uses as part of network modulation strategies.

DBS implantation and stimulation of the centromedian nucleus (CMN) appears to be a safe and efficacious treatment, particularly in patients with refractory generalized epilepsy. CMN stimulation was not as effective in frontal lobe epilepsy, which requires further studies. DBS of the CMN should be considered as a treatment option, particularly in patients with refractory generalized epilepsy syndromes [1)].

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In the largest clinical trial of DBS undertaken in patients with Lennox-Gastaut syndrome (LGS) to date, they show that accurate targeting of the CM is achievable using 3T MP2RAGE MRI. Intraoperative MERs may provide additional localizing features in some cases; however, their utility is limited by interpatient variability. Therapeutic effects of CM-DBS may be mediated via connectivity with brain networks that support diverse arousal, cognitive and sensorimotor processes [2)].

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The intralaminar thalamus is well implicated in the processes of arousal and attention. Stimulation of the intralaminar thalamus has been used therapeutically to improve the level of alertness in minimally conscious individuals and to reduce seizures in refractory epilepsy, both presumably through modulation of thalamocortical function. Little work exists that directly measures the effects of intralaminar thalamic stimulation on cortical physiological arousal in humans. Therefore, the goal of Martin et al. was to quantify cortical physiological arousal in individuals with epilepsy receiving thalamic intralaminar deep brain stimulation.

They recorded scalp electroencephalogram (EEG) during thalamic intralaminar centromedian nucleus stimulation in 11 patients with medically refractory epilepsy. Participants underwent stimulation at 130 Hz and 300 µs for periods of 5 min alternating with 5 min of rest while stimulus voltage was titrated upward from 1 to 5 V. EEG signal power was analyzed in different frequency ranges in relation to stimulus strength and time.

They found a progressive increase in broadband gamma (25-100 Hz) cortical EEG power ($F = 7.64$, $p < .05$) and decrease in alpha (8-13 Hz) power ($F = 4.37$, $p < .05$) with thalamic CM stimulation. Topographic maps showed these changes to be widely distributed across the cortical surface rather than localized to one region.

Previous work has shown that broadband increases in gamma frequency power and decreases in alpha frequency power are generally associated with states of cortical activation and increased arousal/attention. The observed changes, therefore, support the possible role of cortical activation and increased physiological arousal in the therapeutic effects of intralaminar thalamic stimulation for improving both epilepsy and attention. Further investigations with this approach may lead to methods for determining optimal deep brain stimulation parameters to improve clinical outcomes in these disorders [3)].

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Warren AEL, Dalic LJ, Thevathasan W, Roten A, Bulluss KJ, Archer J. Targeting the centromedian thalamic nucleus for deep brain stimulation. J Neurol Neurosurg Psychiatry. 2020 Apr;91(4):339-349. doi: 10.1136/jnnp-2019-322030. Epub 2020 Jan 24. PMID: 31980515.
3)
Martin RA, Cukiert A, Blumenfeld H. Short-term changes in cortical physiological arousal measured by electroencephalography during thalamic centromedian deep brain stimulation. Epilepsia. 2021 Aug 18. doi: 10.1111/epi.17042. Epub ahead of print. PMID: 34405892.