

PACIFIC MOVEMENT DISORDERS CENTER

AT PACIFIC NEUROSCIENCE INSTITUTESM

ESSENTIAL TREMOR: ADVANCED TREATMENT OPTIONS

	Reversible	Laterality	Adjustable over time	Surgery and implant	Battery replacement needed	Frame for surgery	Time to completion	Time to recovery	Time for effect	Hair shaving
Deep Brain Stimulation (DBS)	Yes	Bilateral	Yes	Yes	Yes	Optional	5 hours (+1 hour battery)	Weeks	Immediate	Partial
Focused Ultrasound (FUS)	No	Unilateral	No	No	No	Yes	4 hours	Fast (Days)	Immediate	Full
Radiosurgery	No	Unilateral	No	No	No	Yes	1 hour	Fast	Delayed (months)	No

When patients continue to experience bothersome or disabling essential tremor despite adequate medical therapy, they should be aware of advanced treatment options to control the tremor and improve quality of life. Several modalities are available in the advanced treatment of essential tremor. The best option can vary for different patients and the decision should be individualized. All of the options target the same brain area called the ventral intermediate nucleus of the thalamus (VIM), which can be considered the tremor generator of the brain.

Deep brain stimulation (DBS) is the mainstay of treatment for essential tremor. With this strategy, an electrode is implanted in the VIM. Counterintuitively, stimulation causes suppression of activity of the VIM. The main advantages of DBS are that it is reversible and adjustable, so that treatment can be tailored to the degree of tremor over the course of the condition. Also, DBS can be applied to both sides of the brain to treat tremor on both sides of the body. The reversibility of the procedure improves the safety profile. The disadvantages of DBS are that it requires a neurosurgical procedure with implantation of hardware — the implanted battery must be replaced when it is depleted, typically every 3-4 years. DBS works immediately when initiated but the adjustment to find the optimal settings can take several weeks. In general, DBS will be the preferable option for patients who are in good general health, have a normally functioning immune system, and can undergo brain surgery.

Focused ultrasound (FUS) is the latest breakthrough in treatment of essential tremor, and was FDA-approved in 2016. FUS is performed under direct MRI visualization, creating a lesion (small area of heat damage) to the VIM. The extent of the lesion can be tailored to the patient's symptoms since the therapy is delivered over a few hours and the results are nearly immediate. **Radiosurgery** is an older technology designed to create a lesion in the VIM by use of radiation. It is delivered over a few minutes but takes several weeks to a few months before showing an effect.

The main advantage of FUS and radiosurgery are that they neither require surgery nor the insertion or maintenance of an implanted device. The disadvantage is that they are non-reversible and non-adjustable, so the treatment cannot be changed if the condition worsens in the future. FUS and radiosurgery are generally done only on one side of the brain, controlling tremor only on one side of the body. Radiosurgery can result in longer-term side effects because the effects are not known immediately at the time of the procedure. In general, FUS is more suitable for patients who can't undergo surgery for any reason (personal preference to avoid surgery, high risks with anesthesia or hardware, high risk to discontinue blood thinners, on immunosuppressant therapy).