

Case study

MRgFUS: Essential treatment for essential tremor

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Patients have typically had two main treatment options for essential tremor—oral medications, such as gabapentin, propranolol, primidone and topiramate, and, when tremors are severe, deep brain stimulation (DBS) surgery. DBS is invasive, requiring anesthesia, a skin incision, and opening the skull. For these reasons, patients may be reluctant to pursue DBS therapy. Thus providers are left with few to no options to improve patients' quality of life.

A new, non-invasive tool—MRI-guided focused ultrasound (MRgFUS)—is now an available therapy for essential tremor. The procedure is incisionless and does not require anesthesia. It is conducted inside an MRI scanner and allows providers to localize, target, and monitor the use of ultrasound in real time. While typically used as a diagnostic tool, ultrasound is used in this instance as a therapy.

During the procedure, sound waves are directed from all different angles towards the target, the ventral intermediate nucleus (VIM) of the thalamus. When these sound waves come together in the target, they generate sufficient heat to make a tiny lesion, resulting in a therapeutic effect. Providers can ablate the tissue using sub-millimeter targeting without damaging the normal tissue and structures around it.

Real-time feedback using a special MRI sequence called MR thermometry allows the treatment team to know specifically which tissue has been treated. They can see the immediate impact of the therapy and gives the team the ability to adjust the treatment if needed. The benefits to patients are numerous—most importantly, the therapy is safe and produces both immediate and long-lasting effects. The procedure time is relatively short, often taking 1-2 hours to complete after which patients are discharged home. While the procedure does not treat the underlying disease or prevent disease progression, patients who have had MRgFUS have shown an immediate and significant reduction in tremor, which greatly improves the ability to do everyday activities such as eating, drinking, writing and getting dressed.

Case Illustration

Ms. C is a 79-year old right-handed female with a long-standing history of essential tremor that had worsened over the last few years. She lived alone and adamantly wished to maintain her independence. Her tremors were severe enough that she was unable to cut her own food, hold a cup, brush her teeth or button her clothes.

After consultation, she was deemed a good candidate for unilateral treatment of her right sided tremors. She underwent MRgFUS treatment of her left VIM nucleus. The therapy was effective with near complete resolution of her right upper extremity tremors.

Six weeks after treatment, Ms. C stated she was able to sign her name, feed herself and cook her own food – activities she had been unable to do for the previous 10 years. Ms. C expressed her disappointment for not having undergone the procedure at an earlier age.

This case illustrates a common scenario in patients living with essential tremor. Given the slow progression of disease, patients are often unaware of the severe limitations on their activities of daily living because they adapt until the disease becomes so severe that it threatens independent living.

In the longer term, tremor suppression after MRgFUS for essential tremor is stably maintained at 2 years. Measured scores remained improved from baseline to 36 months (all $p < 0.0001$). The range of improvement from baseline was 38% - 50% in hand tremor, 43% - 56% in disability, 50% - 75% in postural tremor and 27%-42% in quality of life.

When compared to scores at 6 months, median scores increased for hand tremor (95% confidence interval [CI] 0-2, $p = 0.0098$) and disability (95% CI 1-4, $p = 0.0001$). During the third follow-up year, all previously noted adverse events remained mild or moderate, none worsened, 2 resolved and no new adverse events occurred. (See Halpern, Neurology 2019) MRgFUS is performed on an outpatient basis and patients can expect the procedure to last about 2 hours. Prior to the procedure, patients get pre-ablation testing, which includes a CT scan, to check skull density and confirm that therapy will be beneficial.

The treatment is intended for patients at least 22 years of age with essential tremor and for patients at least 30 years of age with parkinsonian tremor who have not adequately responded to medication or other prior treatments.

Once the procedure begins, patients lay on the MRI table with their head cradled in a focused ultrasound helmet. No incisions are made and, because ultrasound is non-ionizing, patients are not exposed to radiation during the procedure. Patients are awake and responsive to evaluate the treatment response.

Generally, MRgFUS is well tolerated. In the short term, patients may experience mild to moderate transient numbness and tingling that can occur from the day of the treatment and up to 3 months after it. Additionally, they may experience headaches/head pain and nausea/vomiting during the treatment. There is a possibility that patients may also experience imbalance, unsteadiness and bruising in the area around the IV catheter, but it usually resolves within a week after treatment.

After 3 months, some of these symptoms may remain, including numbness or tingling, imbalance, unsteadiness, gait disturbance and muscle weakness. However, sensory and gait changes are transient in the great majority of patients and attributed to edema surrounding the ablation site which tends to resolve. MRI images of treatment site at 6 months post-procedure time reveal complete resolution of edema.

Rush University Medical Center is the only center in Illinois, Wisconsin, Iowa and Missouri to offer this procedure.

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