Magnetic Resonance Guided Focused Ultrasound (MRgFUS) Thalamotomy

Magnetic Resonance Guided Focused Ultrasound (MRgFUS) Thalamotomy is an innovative, non-invasive surgical technique

It combines **MRI imaging** with **high-intensity focused ultrasound (HIFU)** to precisely ablate a small region of the thalamus, specifically the **ventral intermediate nucleus (VIM)**, which is involved in the generation of tremors.

Procedure Overview

1. **Patient Preparation:**
    1. The patient's head is immobilized with a frame to ensure accurate targeting.
    2. A stereotactic frame is used to improve precision.
    3. Patients are awake during the procedure to provide feedback.
2. **MRI Guidance:**
    1. MRI provides real-time imaging to visualize the brain and accurately locate the VIM of the thalamus.
    2. MRI thermometry monitors temperature changes in the brain during the procedure.
3. **Focused Ultrasound Application:**
    1. High-intensity ultrasound waves are directed to converge on the VIM of the thalamus.
    2. The focused ultrasound generates heat, causing controlled thermal ablation of the targeted tissue.
4. **Verification:**
    1. After initial low-power sonications, the patient's response is assessed to ensure the correct target is being treated.
    2. Adjustments are made as needed before delivering higher-intensity sonications for permanent ablation.
5. **Completion:**
    1. MRI confirms the lesion's placement.
    2. The patient is monitored for immediate post-procedural effects.

Advantages

- **Non-invasive:** No incisions or craniotomy required.
- **Precision:** MRI guidance ensures accurate targeting and minimizes collateral damage.
- **Minimal Recovery Time:** Patients can often return to daily activities within days.
- **Immediate Results:** Tremor reduction is often noticeable immediately after the procedure.

Indications

Magnetic Resonance Guided Focused Ultrasound Thalamotomy Indications

Limitations

1. Only treats one side of the brain (unilateral tremors).
2. Not suitable for all patients (e.g., those with extensive skull density variations that impede ultrasound transmission).
3. Potential for side effects such as **temporary numbness**, **imbalance**, or **paresthesia**.
4. Long-term effects and durability of results require more study compared to deep brain stimulation (DBS).

Comparison to Deep Brain Stimulation (DBS)

Feature	**MRgFUS Thalamotomy**	**DBS**
Invasiveness	Non-invasive	Invasive
Adjustability	Fixed lesion	Programmable stimulation
Recovery Time	Minimal	Longer recovery
Efficacy for Bilateral Tremor	Limited (unilateral only)	Effective
Side Effects	Heat-related (e.g., numbness)	Device-related risks (e.g., infection)

Future Prospects

Ongoing research is exploring:

- Expanding indications for other neurological and psychiatric conditions (e.g., OCD, depression).
- Enhancing technology to allow bilateral treatments.
- Integrating with other imaging modalities for better targeting.

This technique represents a promising advancement in functional neurosurgery, particularly for patients seeking a less invasive alternative to traditional surgical interventions.

Magnetic resonance guided focused ultrasound (MRgHIFU) thalamotomy destroyed tissues by focusing a high-energy beam on the ventralis intermedius nucleus of the thalamus.

Case reports

A single case report of MR-guided focused ultrasound thalamotomy for tremor in fragile X associated tremor ataxia syndrome [1].

1)

Cerquera C, Rumià J, Herrera JM, Moreno V, Bargalló N, Valldeoriola F. A single case report of MR-guided focused ultrasound thalamotomy for tremor in fragile X-associated tremor/ataxia. Parkinsonism Relat Disord. 2016 Apr 4. pii: S1353-8020(16)30080-3. doi: 10.1016/j.parkreldis.2016.04.002. [Epub ahead of print] PubMed PMID: 27066991.