National Tremor Foundation
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MR Guided Focused Ultrasound Treatment for Tremor

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What is ultrasound?
Electromagnetic spectrum
Focusing Energy

Magnifying glass and sun’s rays to light a fire
Sonication into silicon gel
MRgFUS Surgery Machine

MRgFUS system is integrated into a 3T MRI scanner

Half-spherical ultrasound transducer

Radiofrequency driving electronics

Water cooling & degassing system

Electronic interface for remote control of MRI scanner

Workstation to control the Focussed Ultrasound
MRgFUS done in MR scanner with a frame bolted to the skull. Mean accuracy: 0.72 mm.

The patient is awake throughout & regularly examined for GOOD & BAD effects.
InsighTec – Ex Ablate Neuro

1004 ultrasound beams focus on the target

Target: VIM
Ventralis Intermedius
Nucleus of thalamus

Effect:
Reduces tremor in the Opposite arm
Simulation of a MRgFUS procedure
MRgFUS Thalamotomy

Lesion
What does MRgFUS Surgery involve?

The Patients must: **NOT BE CLAUSTROPHOBIC**

1. be able to have a **CT scan** and **MRI scan**

2. allow their head to be **completely shaved**

3. tolerate being in a MRI scanner for **4-5 hours**

4. be able to **communicate** during the procedure

5. be able to press the **stop sonication** button
What has MRgFUS be used for?

Neurological (brain):
1. Essential tremor
2. Parkinson’s disease
3. Neuropathic pain
4. Epilepsy

Other medical uses:
1. Uterine fibroids
2. Prostate cancer
3. Breast cancer
4. Liver metastases
4. Bone metastases
Where has MRgFUS treatment been used for essential tremor?

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**United Kingdom**
1. Imperial College Healthcare NHS Trust (St Mary’s Hospital)

18 centres worldwide
Multicentre MRgFUS Study for ET

Inclusion Criteria

1. Age $\geq$ 22 years
2. Moderate or severe ET
3. Diagnosis of ET confirmed by a movement disorder specialist
4. Able to give consent & willing to attend all study visits
5. Inadequate response to 2 or more anti-ET medications
6. Significant disability from ET

Every suitable patient will get MRgFUS surgery
Multicentre MRgFUS Study for ET

Seven study visits:

1. Baseline – enrolment & CT scan
2. Treatment – MRgFUS
3. 1 week – 1st Follow up visit
4. 1 month – 2nd Follow up visit
5. 3 months – 3rd Follow up visit
6. 6 months – 4th Follow up visit
7. 12 months – 5th Follow up visit
Multicentre MRgFUS Study for ET

Except for the following exclusion criteria:

1. Unstable cardiac disease or other life threatening illness
2. Severe High Blood Pressure
3. Drug or alcohol addiction
4. Advanced kidney disease (contrast media)
5. History of abnormal blood clotting
6. Anticoagulants (e.g. warfarin or aspirin) within 1 week of MRgFUS
7. Active infections including HIV
8. History of recent or multiple strokes
9. Presence of Parkinson’s or other neurodegenerative diseases
10. Significant cognitive impairment or depression
11. History of epileptic seizures within 1 year
12. Presence of a brain tumour or raised intracranial pressure
13. Pregnant or lactating
14. Previous DBS or stereotactic surgery to target area
15. Cardiac pacemaker in patient
Patients should have a:

Skull Density Ratio ≥ 0.45

The SDR is obtained from a CT head scan taken 1 month before MRgFUS surgery.

A high SDR causes a higher energy and thus temperature at the target site for a given ultrasound input energy.
Results: MRgFUS for Essential Tremor

Study of 15 People treated unilaterally for ET

Results:
- Hand tremor improved by: 75%
- Total tremor improved by: 56%
- Disability scores decreased by: 85%
- Quality of Life improved by: 65%
Results: MRgFUS for Essential Tremor

Post-operative adverse effects are usually transient

- Paraesthesias in the hand
- Unsteady gait
- Mild speech disturbance
- Deep vein thrombosis
Future developments:

I anticipate that MRgFUS will:

1. Gradually be rolled out for treating all types of tremor
2. Be used to treat tremor bilaterally
3. Be used to treat other movement disorders
4. Be used with less strict inclusion & exclusion criteria
Thanks to the NTF for funding:

Dr Nada Yousif
Post-doctoral research fellow
Imperial College London

To work on the MRgFUS Essential Tremor Study