Preliminary study of thalamic parcellization for the identification of the treatment target in trans-cranial talamotomies induced by focused ultrasound guided through Magnetic Resonance (tcMRgFUS)

Giorgio Collura (UNIPA and INFN-CT)

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Surgical therapy using magnetic resonance-guided focused ultrasound

(**M**agnetic **R**esonance **g**uided **F**ocused **U**ltrasounds **S**urgery **MRgFUS**)

is a modern and non-invasive ablative technique.

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is a modern and non-invasive ablative technique.

Recent technological developments enabled MRI-guided therapeutic application of HI-FU to the brain

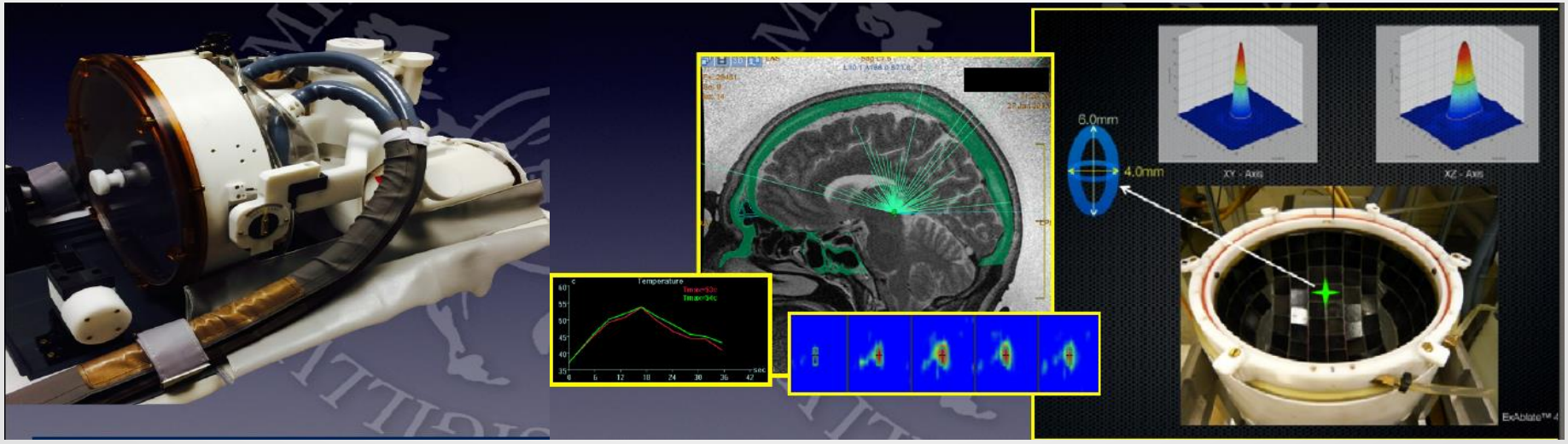
(**t**rans**c**ranial MRgFUS - tcMRgFUS)

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

This Focused Ultrasound (FUS) equipment

(ExAblate 4000, InSightec Ltd. - Haifa, Israel)

consists of an hemispheric 1024-element phased-array transducer operating at 650 kHz.



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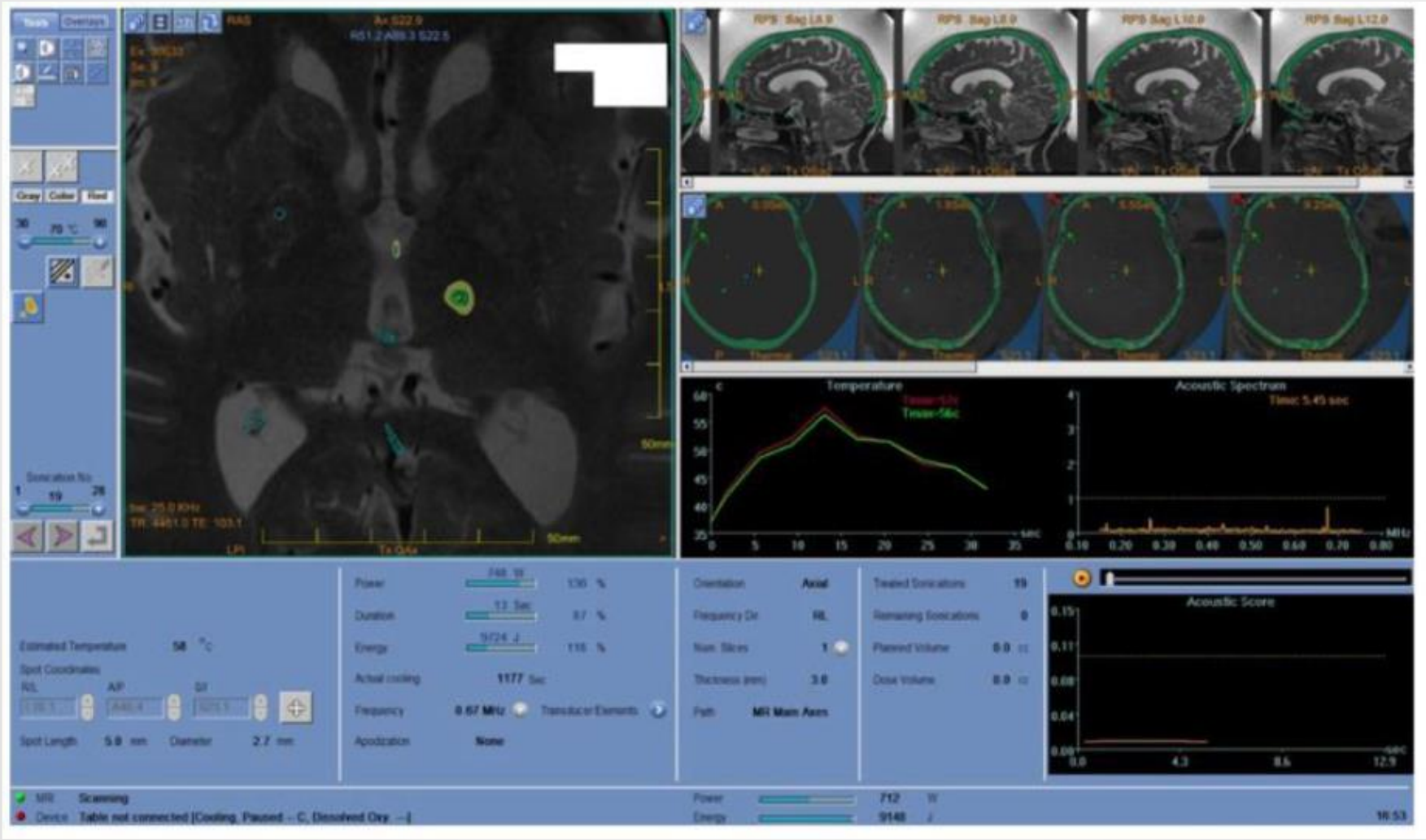

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Planning images obtained using a 1.5T MRI's body RF coil showed reasonable quality in terms of:

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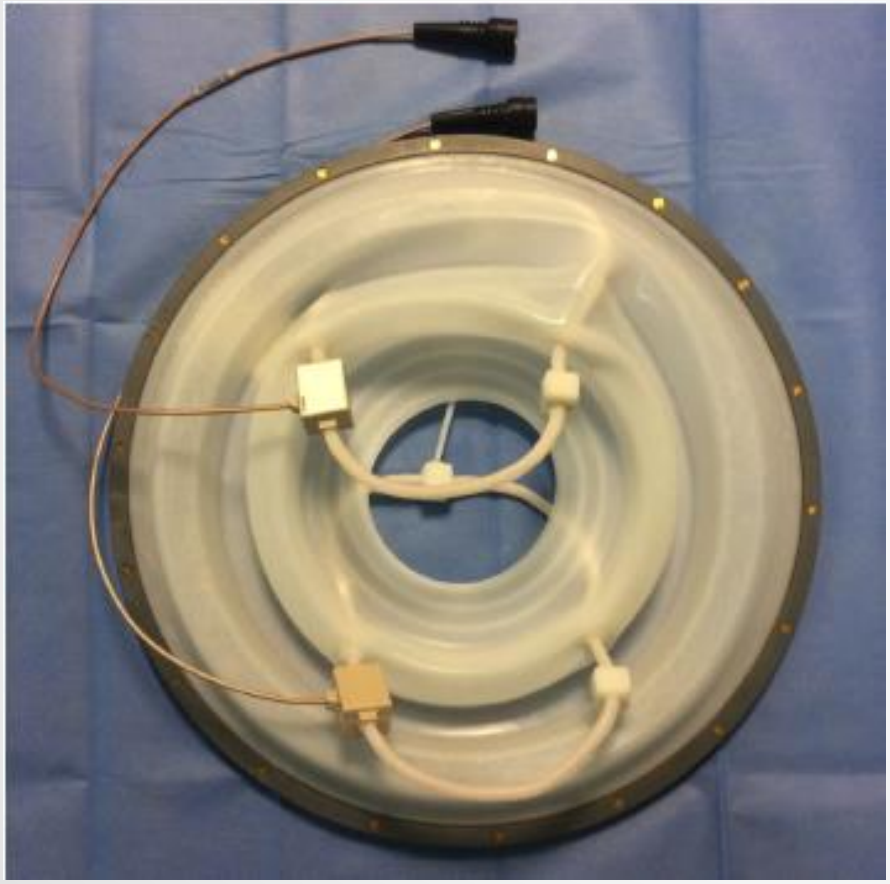
but

thermal images noise was **NOT acceptable**.

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T



2ch FUS-Head coil (InSightec Ltd. - Haifa, Israel)

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

The application of this technique requires a precise delimitation of the area of the brain to be treated with focused ultrasound.

The ultrasound energy is focused on a very small volume of tissue that you want to remove.

This causes an increase in temperature sufficient to destroy the cells in the target volume, without damaging the surrounding tissues.

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

tcMRgFUS offers an incisionless approach to treat movement disorders

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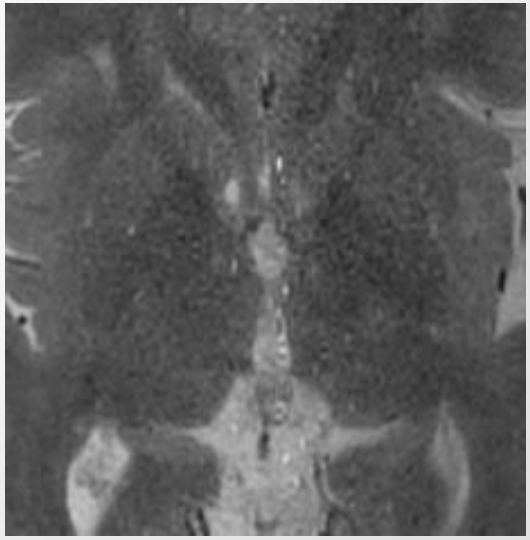

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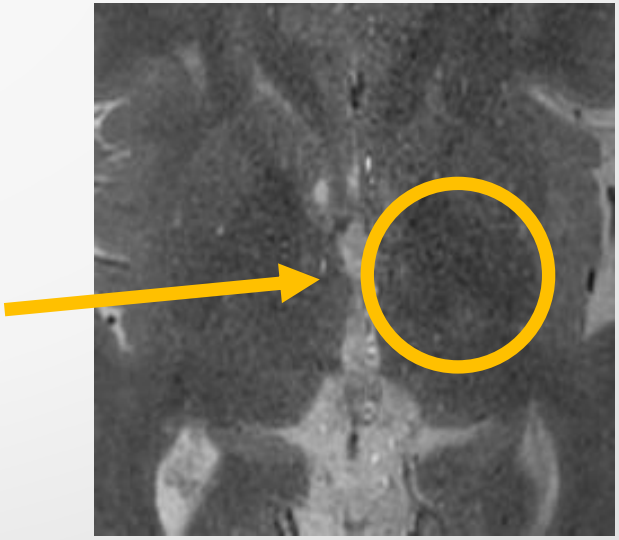
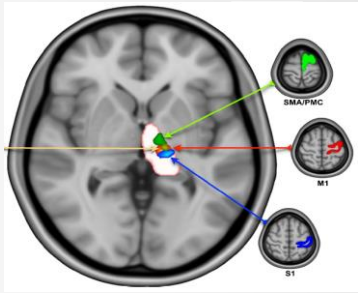
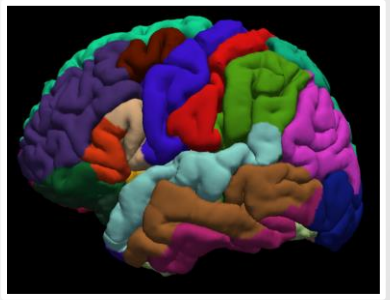


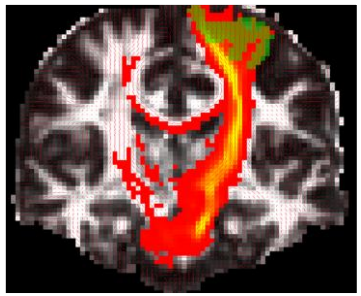
Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

The aim of this study is to identify the **VIM** with a more accurate method.



Probabilistic tractography may potentially be used to increase the efficacy and consistency of outcomes with **tcMRgFUS** and potentially shorten treatment times by identifying optimal targets in advance of treatment.





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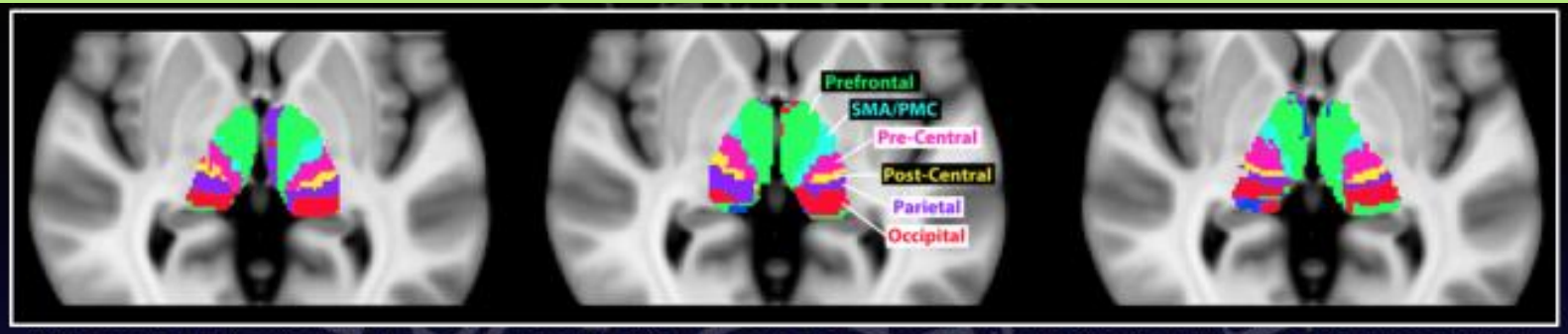
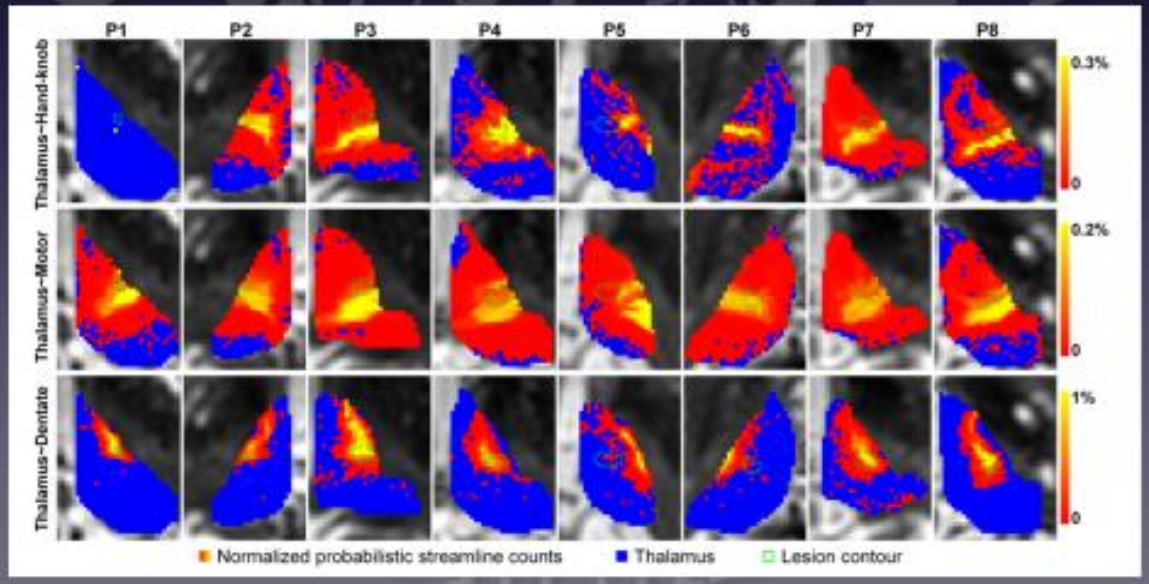


Middlebrooks et al. A method for pre-operative single-subject thalamic segmentation based on probabilistic tractography for essential tremor deep brain stimulation. Neuroradiology. 2018 Mar;60(3):303-309. doi: 10.1007/s00234-017-1972-2. Epub 2018 Jan 6.

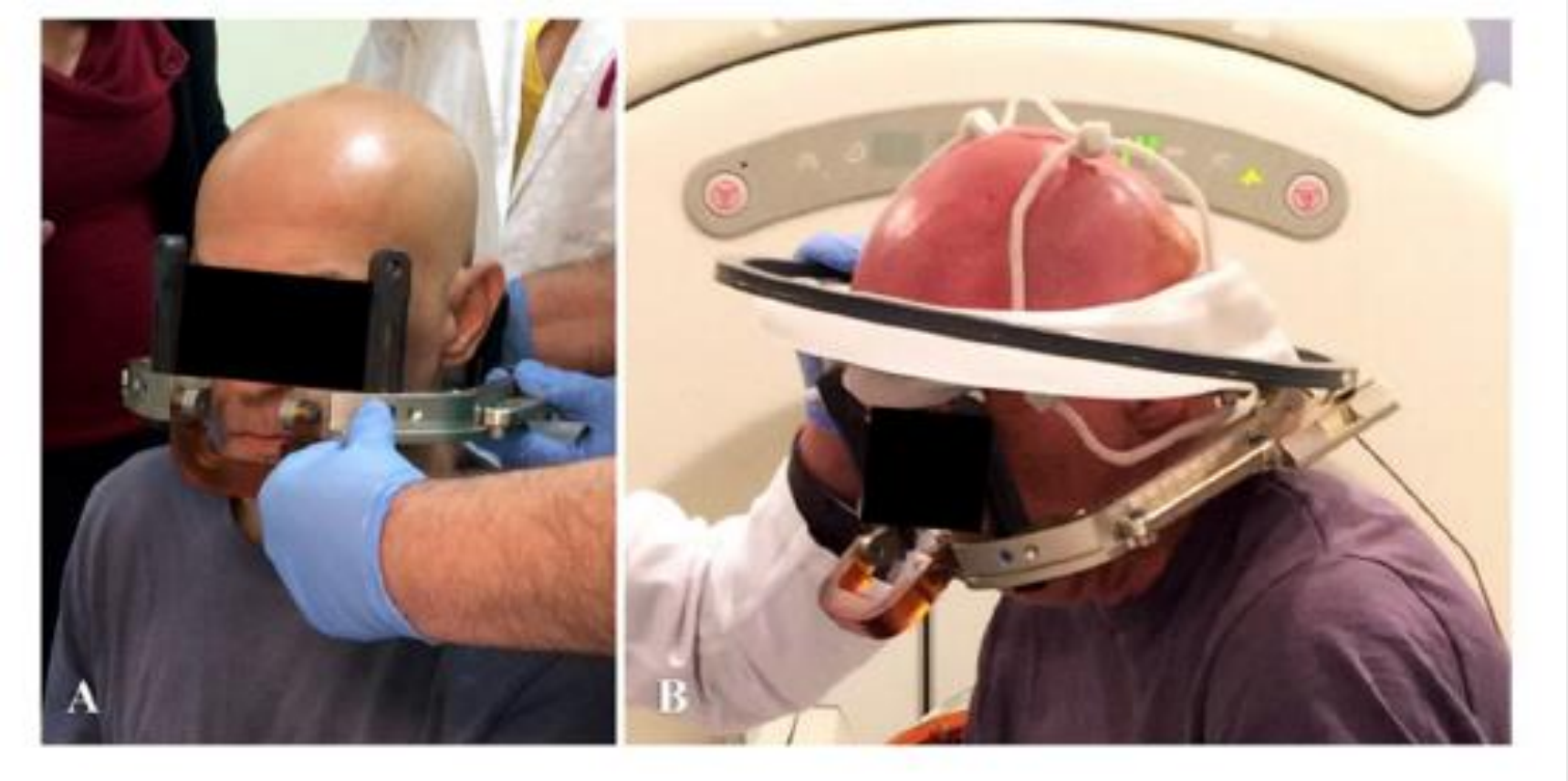


Tian et al. Diffusion MRI tractography for improved transcranial MRI-guided focused ultrasound thalamotomy targeting for essential tremor. Neuroimage Clin. 2018 May 9;19:572-580. doi: 10.1016/j.nicl.2018.05.010. eCollection 2018.

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Video n1

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T



Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Video n2

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Video n3

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Preoperative T1, T2 and diffusion weighted MRI acquisition Imaging was performed on a 1.5T scanner using a 32 channel receive head coil.

Diffusion-weighting, with b=1000 s/mm2, was applied along 30 directions uniformly distributed on the sphere and two b=0 s volumes were also acquired.

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

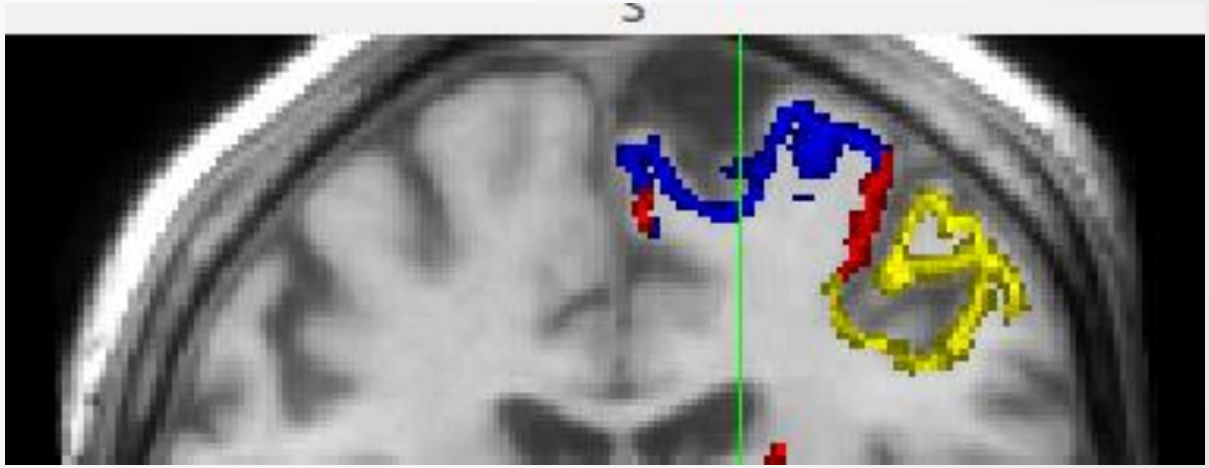
BedpostX (FSL v 5.0.9) was used to estimate fibre orientations. Up to two crossing fibres were estimated in each brain voxel.

Cortical reconstruction and volumetric segmentation of T1 weighted volume was performed with the Freesurfer image analysis suite.

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Cortical volumetric masks of:

- supplementary motor area (SMA) and premotor cortex (PMC)
- precentral cortex
- postcentral cortex



were generated.

Transcranial Magnetic Resonance-guided Focused Ultrasound Surgery (tcMRgFUS) at 1.5T

Probabilistic tractography was generated in ProbtrackX2 (FSL v 5.0.9) (number of samples=5000, curvature-threshold=0.2, step length=0.5mm subsidiary fibre volume fraction threshold=0.01).

The process repetitively samples from the distributions of voxel-wise principal diffusion directions, building up a spatial ‘connectivity distribution’.

Preliminary Results

Thalamic segmentation was carried out for the first patients

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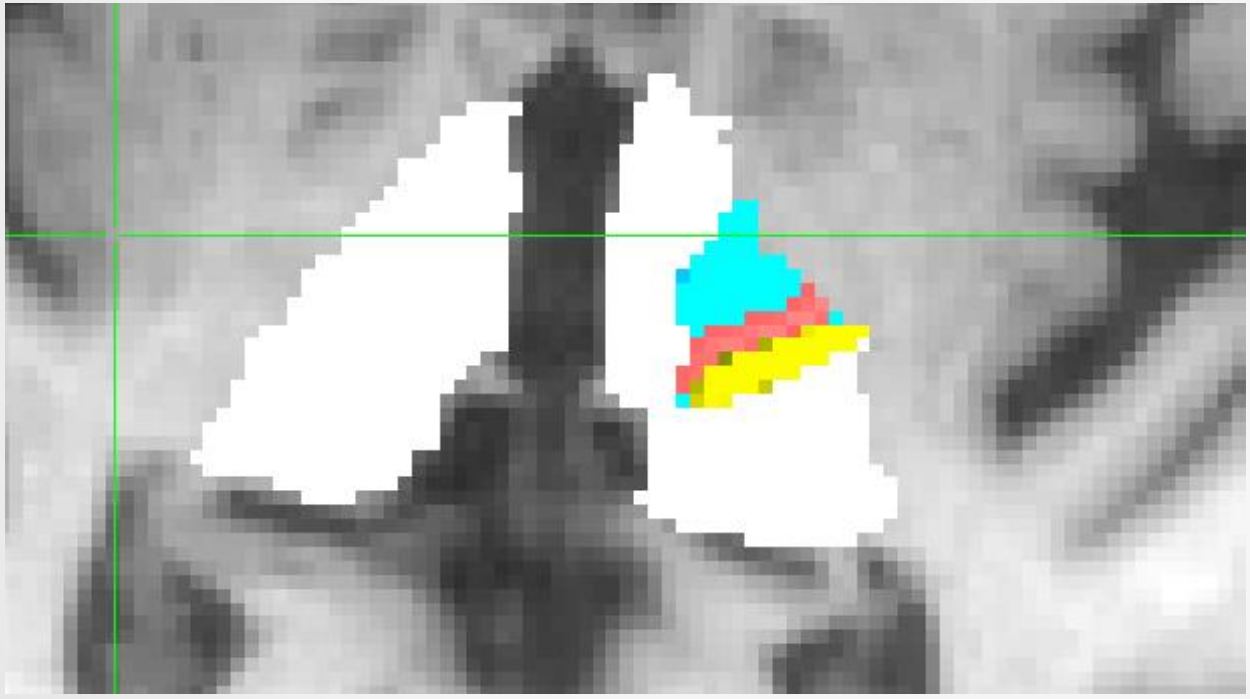

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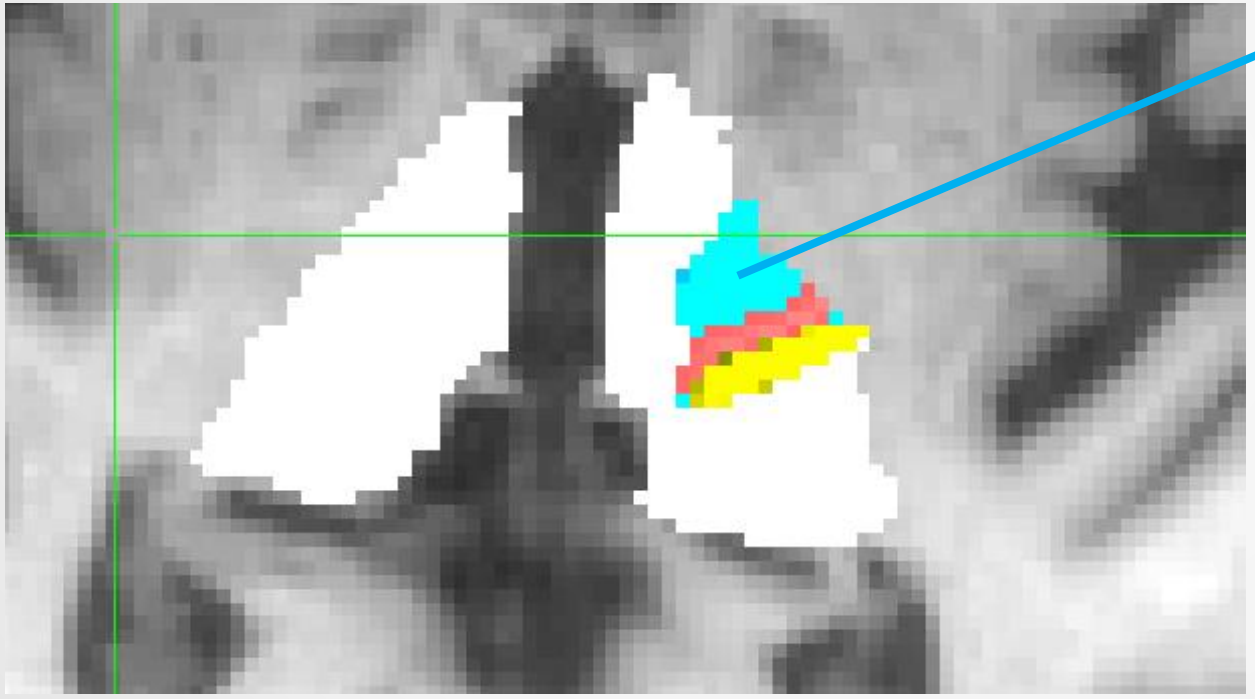

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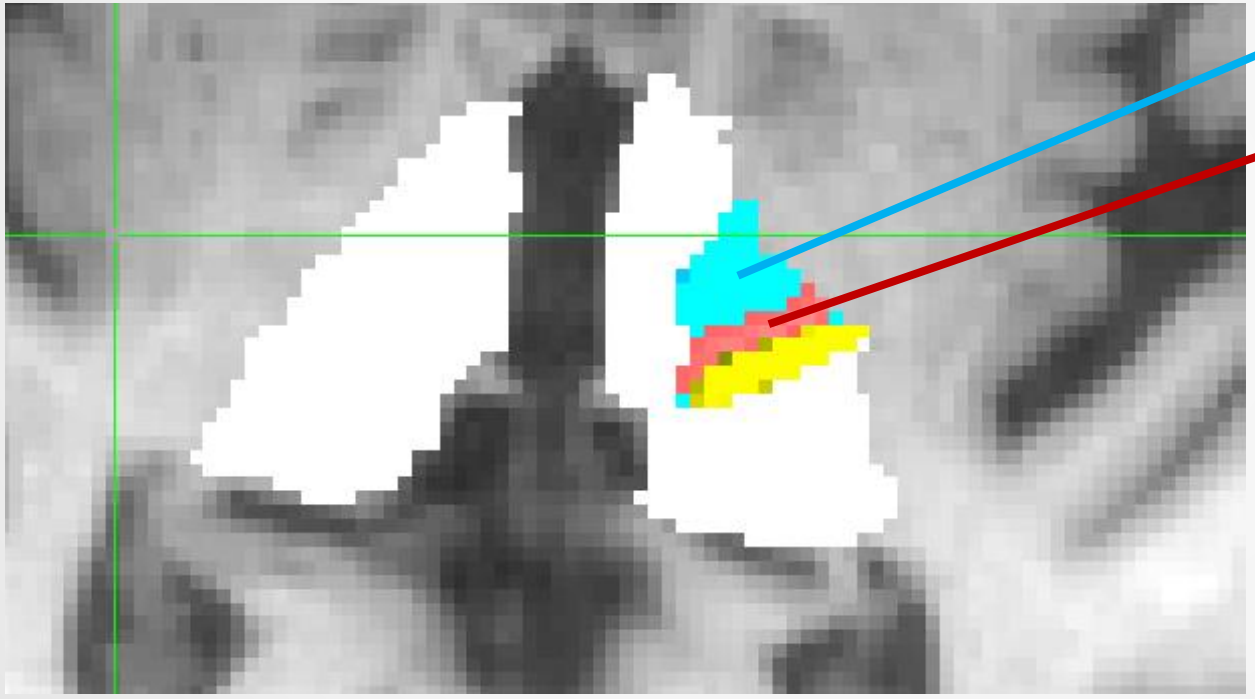

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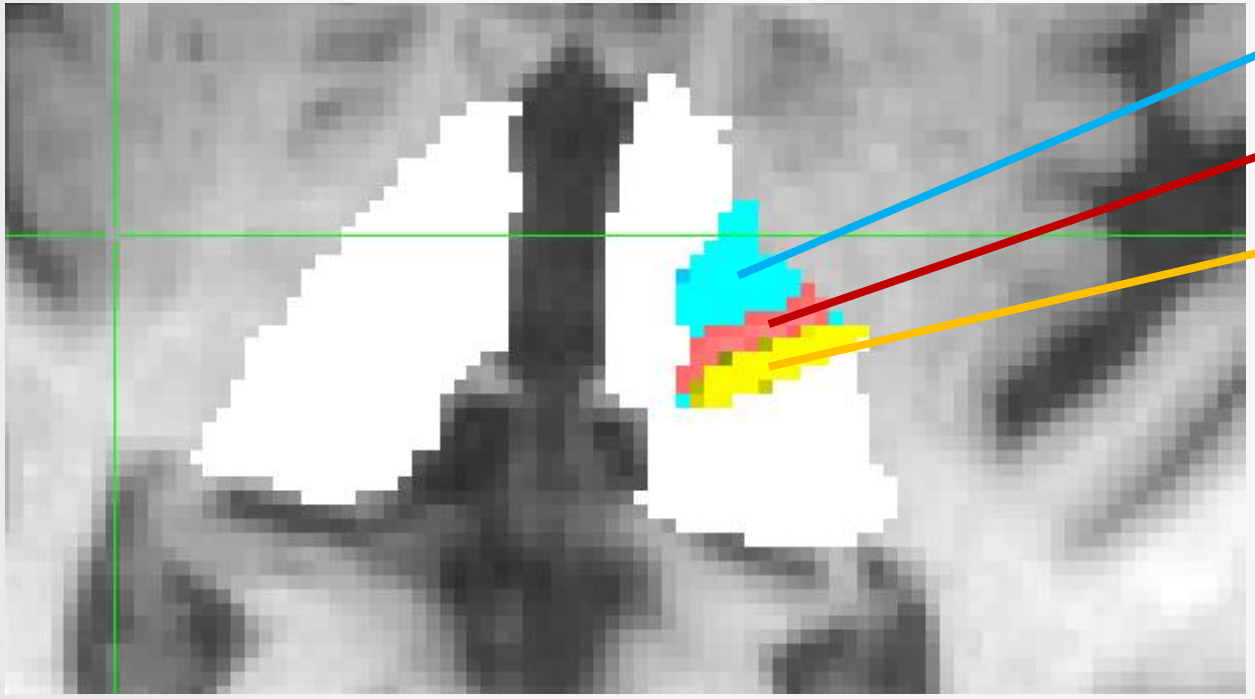
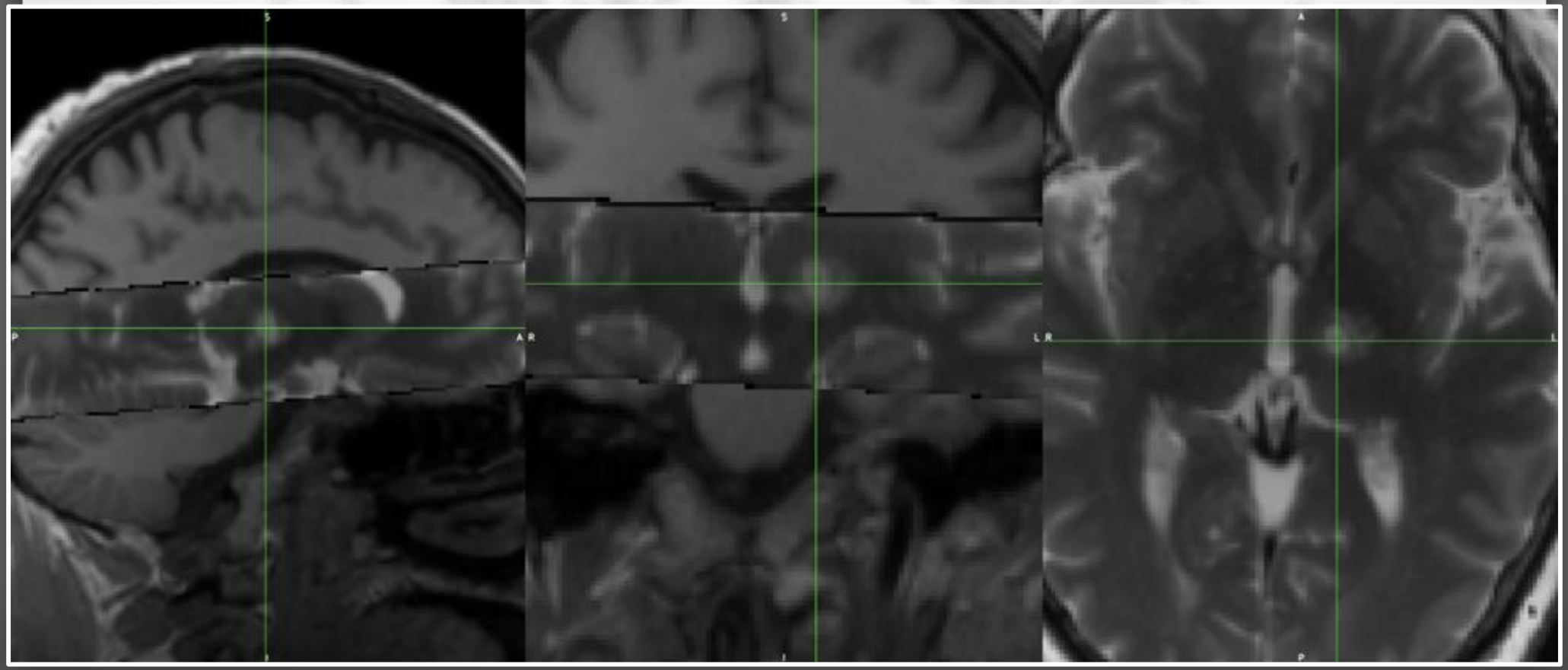


Preliminary Results: retrospective analysis

Example of thalamic parcellation in a patient with excellent clinical outcome (followup> 2aa)



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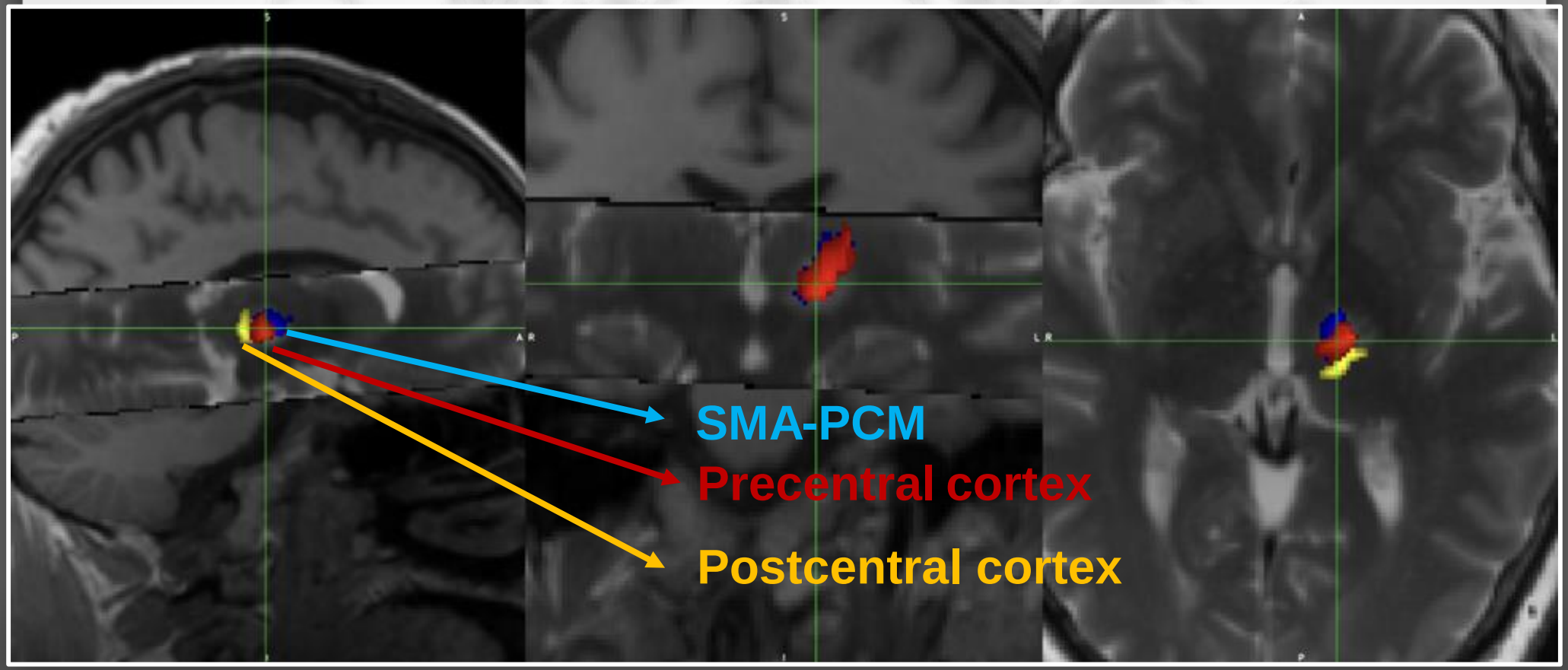
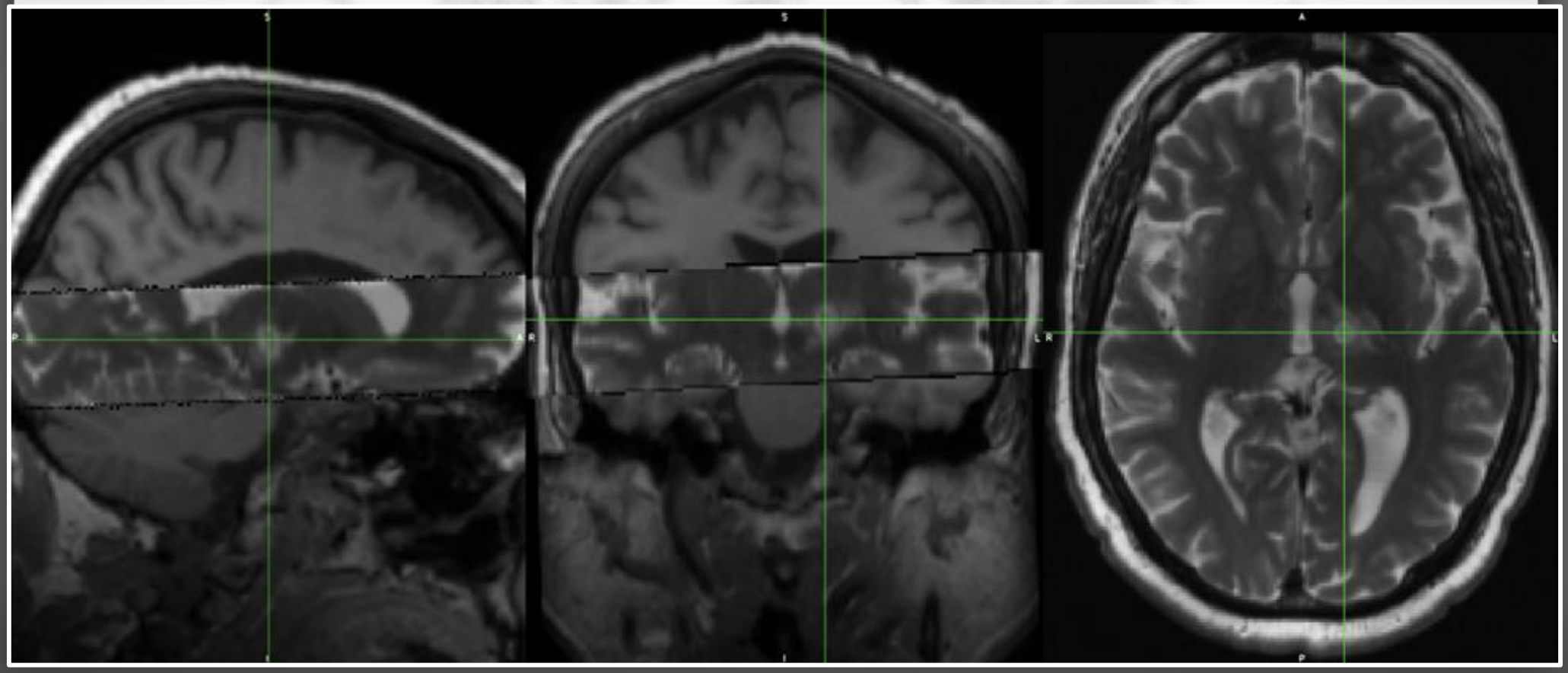


Preliminary Results: retrospective analysis

Example of thalamic parcellation in a patient with poor clinical outcome 3 months after treatment



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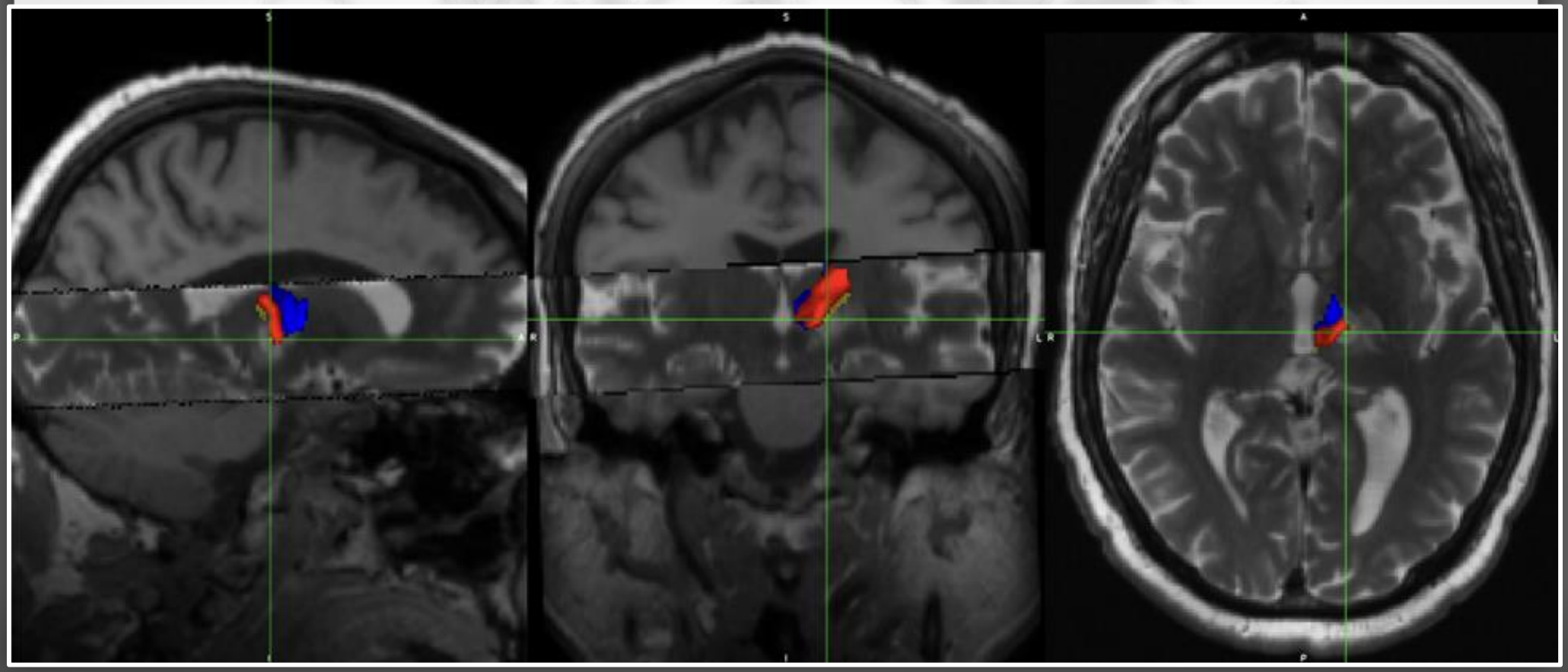


Funding

Ricerca Finalizzata Bando 2016
Progetto Under 40

Trans-cranial MRgFUS for the treatment of medication refractory essential tremor: Italian and world-first trial using a 1.5T MR unit.

P.I.:Cesare Gagliardo.

Other Units P.I.: Francesca Valentino and Maurizio Marrale

Funding

GIORNALE DI SICILIA
MARTEDÌ 30 GENNAIO 2018

POLICLINICO. Lo studio si basa sull'uso di un'apparecchiatura in grado di effettuare la terapia trans-cranica mediante ultrasuoni focalizzati ad alta densità sui pazienti

Tremore invalidante, finanziato un progetto

Il gruppo dell'Ateneo è tra i vincitori del bando «Ricerca Finalizzata 2016» del ministero della Salute. Pronti 900 mila euro

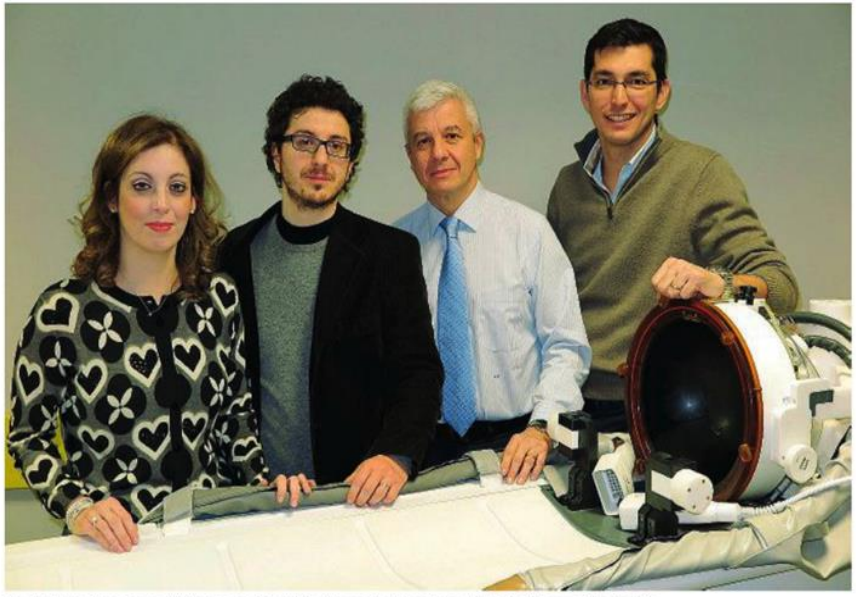
Il progetto sarà condotto al Policlinico. Il tremore essenziale è una condizione neurologica molto comune, spesso rende impossibili anche il bere, il mangiare, il vestirsi o usare uno smartphone.

Alessandra Turrisi

••• Finanziato con quasi 900 mila euro a un gruppo di giovani ricercatori palermitani del Policlinico il primo studio clinico su pazienti con tremore essenziale. Un progetto reso possibile dalla prima apparecchiatura in una struttura sanitaria pubblica, in grado di effettuare la terapia trans-cranica mediante ultrasuoni focalizzati ad alta densità sui pazienti affetti da Parkinson, dal dolore neuropatico cronico, dal quel tremore invalidante che rende impossibile una vita normale.

I giovani ricercatori dell'Ateneo palermitano risultano tra i vincitori del bando «Ricerca Finalizzata 2016» del ministero della Salute. Responsabile del progetto è Cesare Gagliardo (neuroradiologo), coadiuvato da Francesca Valentino (neurologo), Maurizio Marrale (fisico) e da Rosario Maugeri (neurochirurgo). Sono state oltre 1500 le domande di finanziamento inviate al ministero per superare una prima selezione e solo 138 i progetti presentati da giovani ricercatori premiati a seguito di una valutazione da parte di esperti internazionali. Con nove progetti finanziati la Sicilia ottiene un risultato importante.

«Il finanziamento - spiega Gagliardo - servirà per supportare il primo studio clinico sul territorio nazionale su pazienti con tremore essenziale: condizione neurologica molto comune, spesso in grado di inficiare pesantemente la qualità di vita dei pazienti rendendo impossibili anche le più banali operazioni della vita quotidiana come il bere, il mangiare, il vestirsi o usare uno smartphone. I pazienti candidabili verranno sottoposti a un'innovativa terapia non invasiva che utilizza un fascio di ultrasuoni ad alta intensità guidati da risonanza magnetica per effettuare delle microablazioni in importantissimi nuclei cerebrali profondi attraverso il tavolato cranico integro con un beneficio clinico immediato».



Da sinistra Francesca Valentino, Maurizio Marrale, Massimo Midiri e Cesare Gagliardo

Il progetto da 882.500 euro, finanziato dal ministero della Salute e co-finanziato dalla Regione siciliana, sarà condotto al Policlinico. «È questo - conclude Gagliardo - il risultato di un percorso iniziato all'Istituto di Radiologia diretto da Roberto Lagalla negli ultimi mesi del 2014. Grazie alla collaborazione con La Sapienza di Roma, è stata installata la prima apparecchiatura sul territorio nazionale per il trattamento dei disordini neurologici mediante l'uso di ultrasuoni focalizzati guidati da risonanza magnetica. Negli anni successivi è stato costituito un gruppo multidisciplinare e pluri-specialistico». Tra le unità operative coinvolte nel progetto ci sono la Radiologia guidata da Massimo Midiri (con Tommaso Vincenzo Bartolotta e Giuseppe La Tona), la Neurologia (Brigida Fierro, Marco D'Amelio, Giuseppe Cosentino), la Neurochirurgia (Gerardo Domenico Iacopino, Antonella Giugno) e il dipartimento di Fisica e Chimica (Antonio Bartolotta, Maria Brai). (*ALTU*)


thank you
danke
謝謝
ngiyabonga
teşekkür ederim
gracias
merci
obrigado
dziękuję
bedankt
go raibh maith agat
sukriya
kop khun krap
terima kasih
grazie
arigatō
dakujem
takk
tapadh leat
mochchakkeram
спасибо
рахмат
Баярлалаа
faafetai lava
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dank je
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