

Conférence Internationale sur invitations

7 conférences plénierées / 11 Key Notes / 36 sessions orales /20 posters

- **US médicaux**  
-> diagnostiques et thérapeutiques
  - HIFU High Intensity Focused Ultrasound (détruire, hyper-thermie)
  - LIFU Low Intensity Focused Ultrasound (stimuler, sonification)
  - Microbulles chargées en médicaments
  - Sonopharmacologie / sonogénétiques
- **US process chimiques (agroalimentaire, proceeds extraction proteins, nettoyage ...)**  
-> Faisabilité à moindre coût énergétique. Fonctionnement pas toujours formalisé
- **Mesures processus physiques : i.e. taille nanoparticules**
- **Détection défauts**
- **Détection d'intrusion**

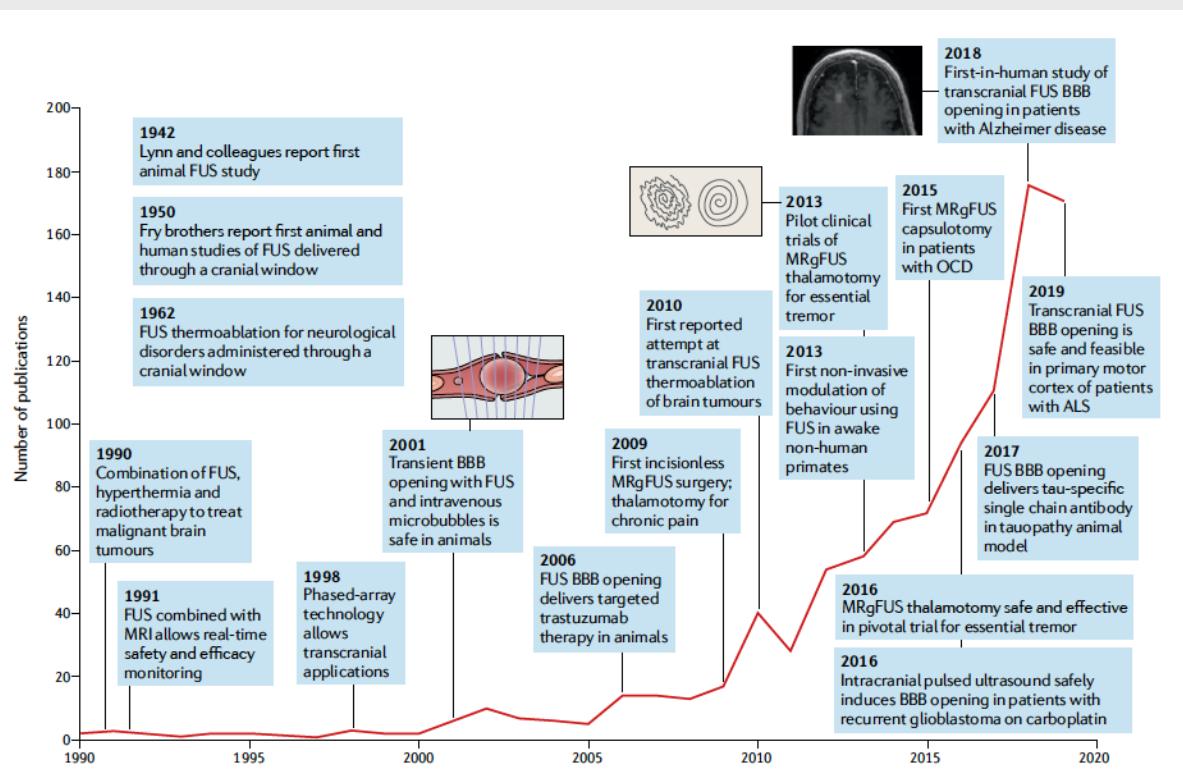
# MRigFUS : MRI guided Focused US (K Hynnen)

## Applications of focused ultrasound in the brain: from thermoablation to drug delivery

Ying Meng  <sup>1,2,3</sup>, Kullervo Hynnen  <sup>4,5</sup> and Nir Lipsman  <sup>1,2,3</sup> 

NATURE REVIEWS | NEUROLOGY

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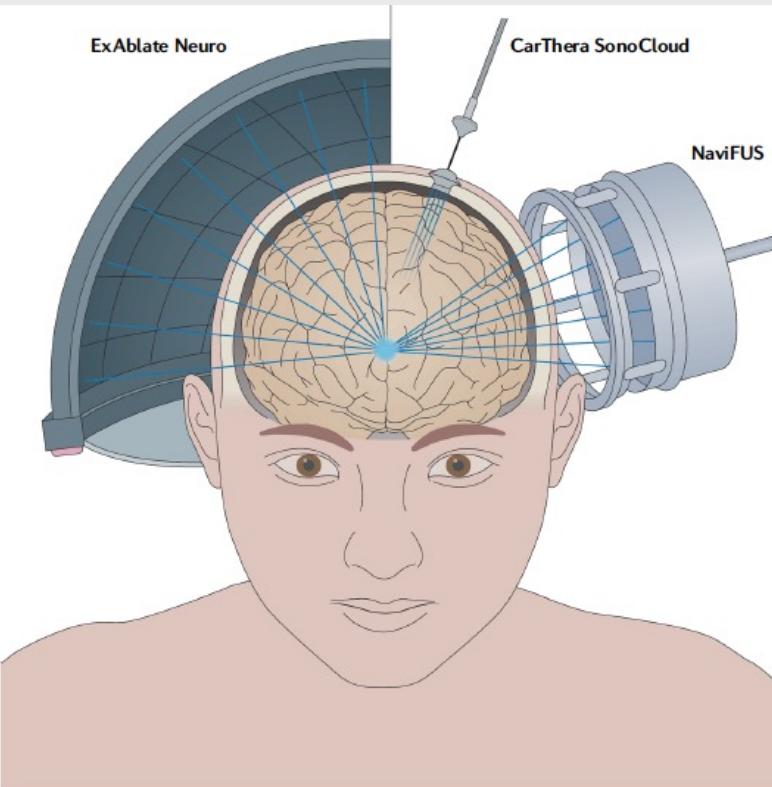


### Key points

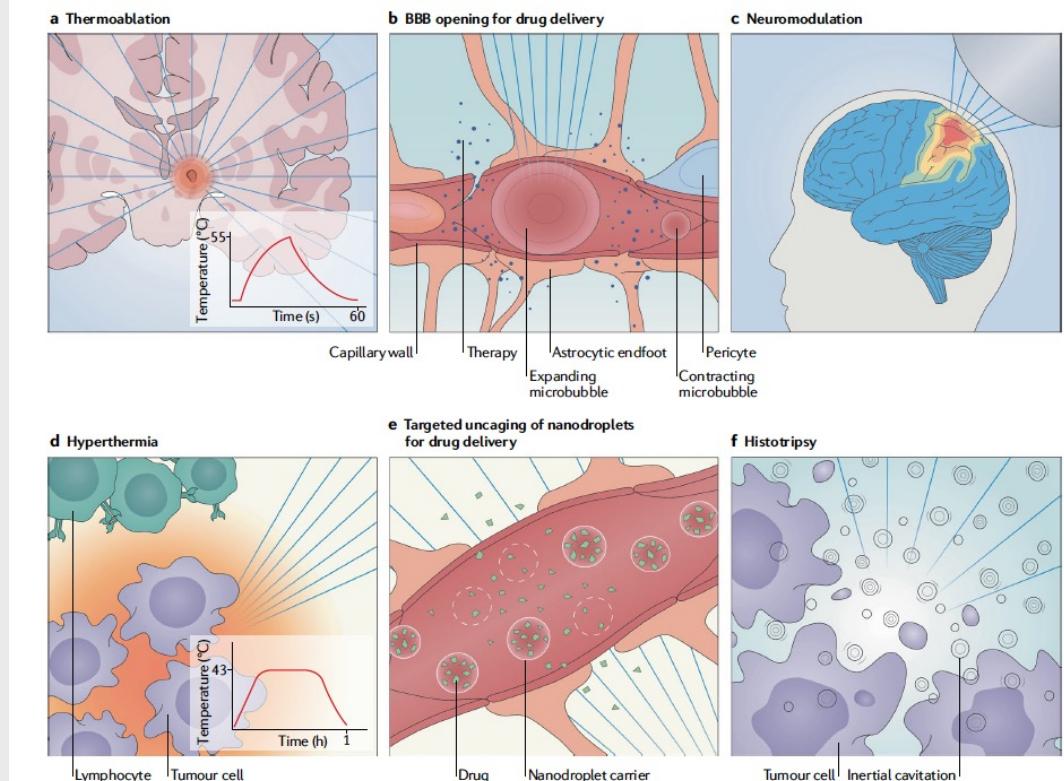
- Recent advances have led to a surge of interest in focused ultrasound (FUS) as a non-invasive, potentially disruptive tool for the most intractable neurological conditions.
- Magnetic resonance-guided FUS thermoablation has been approved for the treatment of essential tremor and tremor-dominant Parkinson disease and is being investigated in psychiatric applications as well as in chronic pain and epilepsy.
- Transient opening of the blood-brain barrier for drug delivery is a burgeoning field, with early human studies demonstrating a favourable safety profile as well as versatility across and scalability within a range of clinical indications.
- Future studies will investigate the delivery of established pharmaceuticals and novel therapies in combination with FUS blood-brain barrier opening.
- Emerging applications are also harnessing the myriad of ways in which FUS can interact with the CNS, including immune modulation and neuromodulation.

# Neurostimulation (MRIgFUS)

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**Fig. 2 | Current therapeutic ultrasound devices for brain applications.** The ExAblate Neuro system comprises a phased array of transducers coupled to an MRI system. The elements line the concave inner surface of a helmet that is placed close to the scalp with intervening degassed water. NaviFUS is another transcranial system. Like ExAblate Neuro, NaviFUS is multi-channelled but with fewer elements on a smaller surface area. Navigation of the device is based on pre-procedure imaging. The CarThera SonoCloud implanted ultrasound device is powered through a bipolar needle introduced through the skin for each treatment. The ExAblate Neuro systems are employed for both thermoablation and blood-brain barrier opening whereas NaviFUS and CarThera SonoCloud are currently being investigated for blood-brain barrier opening.



**Fig. 3 | Biological effects of FUS.** The diverse biological effects of focused ultrasound (FUS) on tissue can be categorized as predominantly thermal or mechanical. The top panels illustrate the effects that have been demonstrated so far in humans. High-intensity FUS delivered through the intact skull creates a coagulative necrotic lesion with millimetric precision for incisionless neurosurgery (part a). Stable cavitation of intravascular microbubbles under FUS induces mechanical forces on the blood-brain barrier (BBB) that transiently increase its permeability for drug delivery (part b). FUS neuromodulation potentially offers higher spatial and temporal resolution than existing techniques, with the ability to non-invasively target deep brain regions (part c). The bottom panels illustrate emerging FUS effects that are at more preliminary stages of development. Hyperthermia to increase radiosensitivity and immunogenicity of tumour cells (part d). Ultrasound-responsive drug carriers for targeted delivery (part e). Histoacryl for non-invasive mechanical fractionation of large volumes of tissue or blood clot (part f).

SCIENCE TRANSLATIONAL MEDICINE | RESEARCH ARTICLE

DRUG DELIVERY

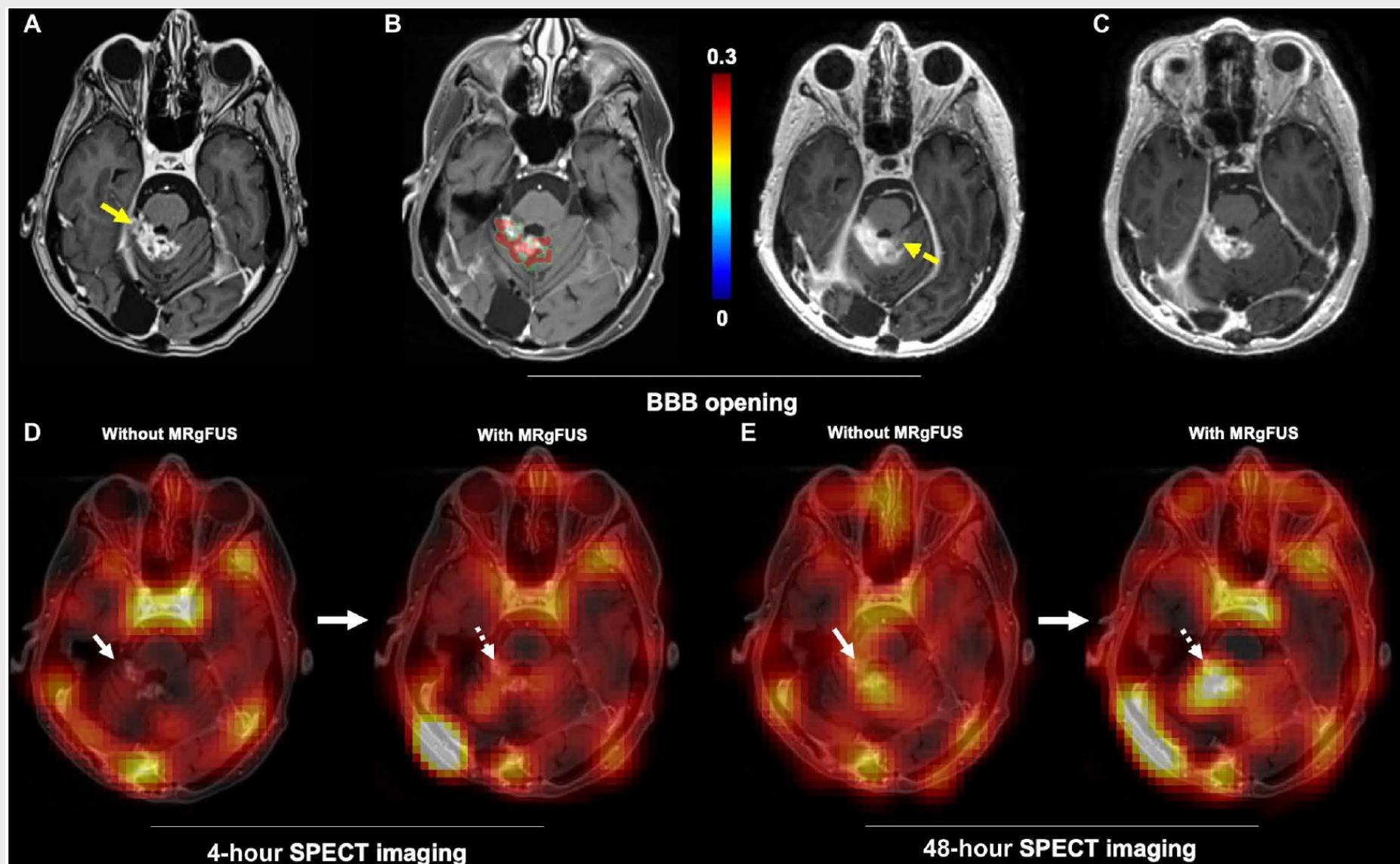
## MR-guided focused ultrasound enhances delivery of trastuzumab to Her2-positive brain metastases

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Arjun Sahgal<sup>5,7</sup>, Amit Singnurkar<sup>8</sup>, James Perry<sup>5,6,9</sup>, Sten Myrehaug<sup>5,7</sup>, Christopher B. Pople<sup>1</sup>,  
Benjamin Davidson<sup>1,2</sup>, Maheleth Llinas<sup>1</sup>, Chinthaka Hyen<sup>1,8</sup>, Yuexi Huang<sup>1</sup>, Clement Hamani<sup>1,2</sup>,  
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Meng *et al.*, *Sci. Transl. Med.* **13**, eabj4011 (2021) 13 October 2021

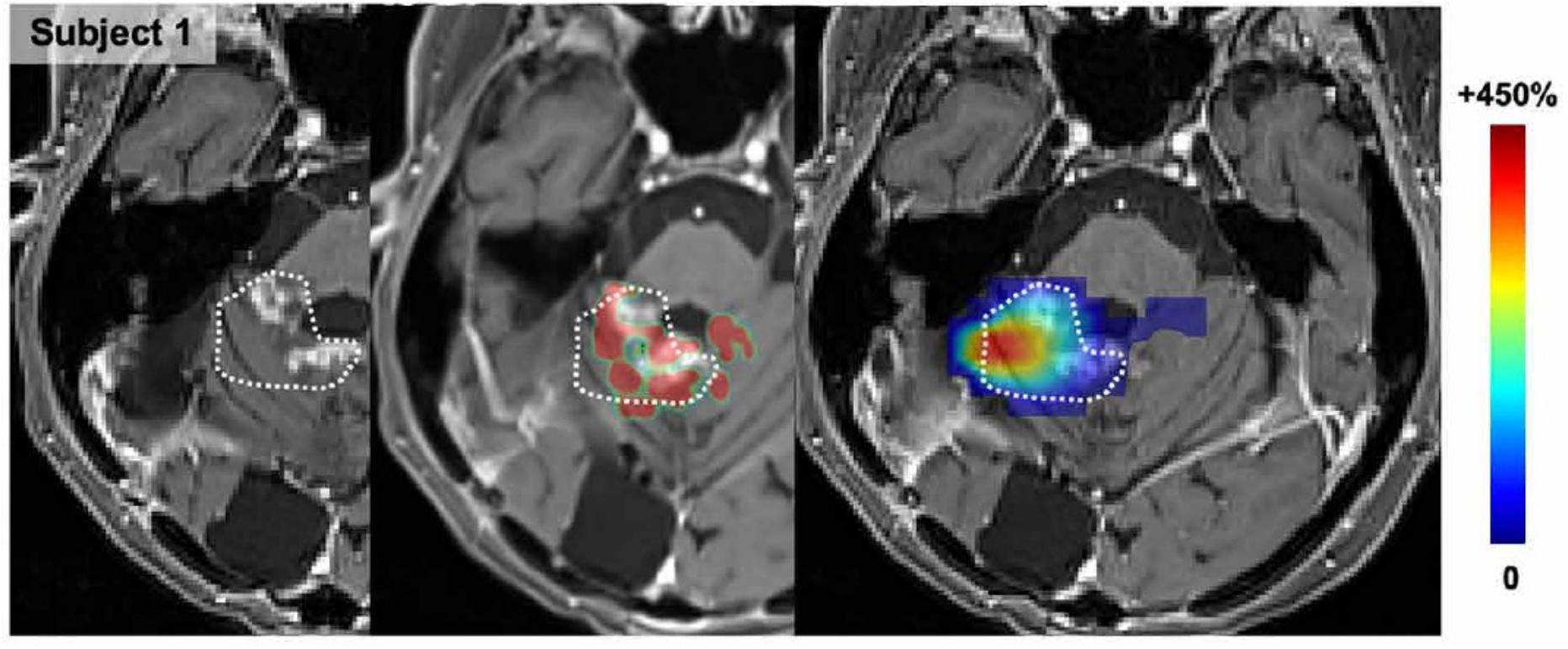
first-in-human report of noninvasive, spatially targeted monoclonal antibody delivery across the BBB with MRgFUS.

# Traitements métastases cérébrales

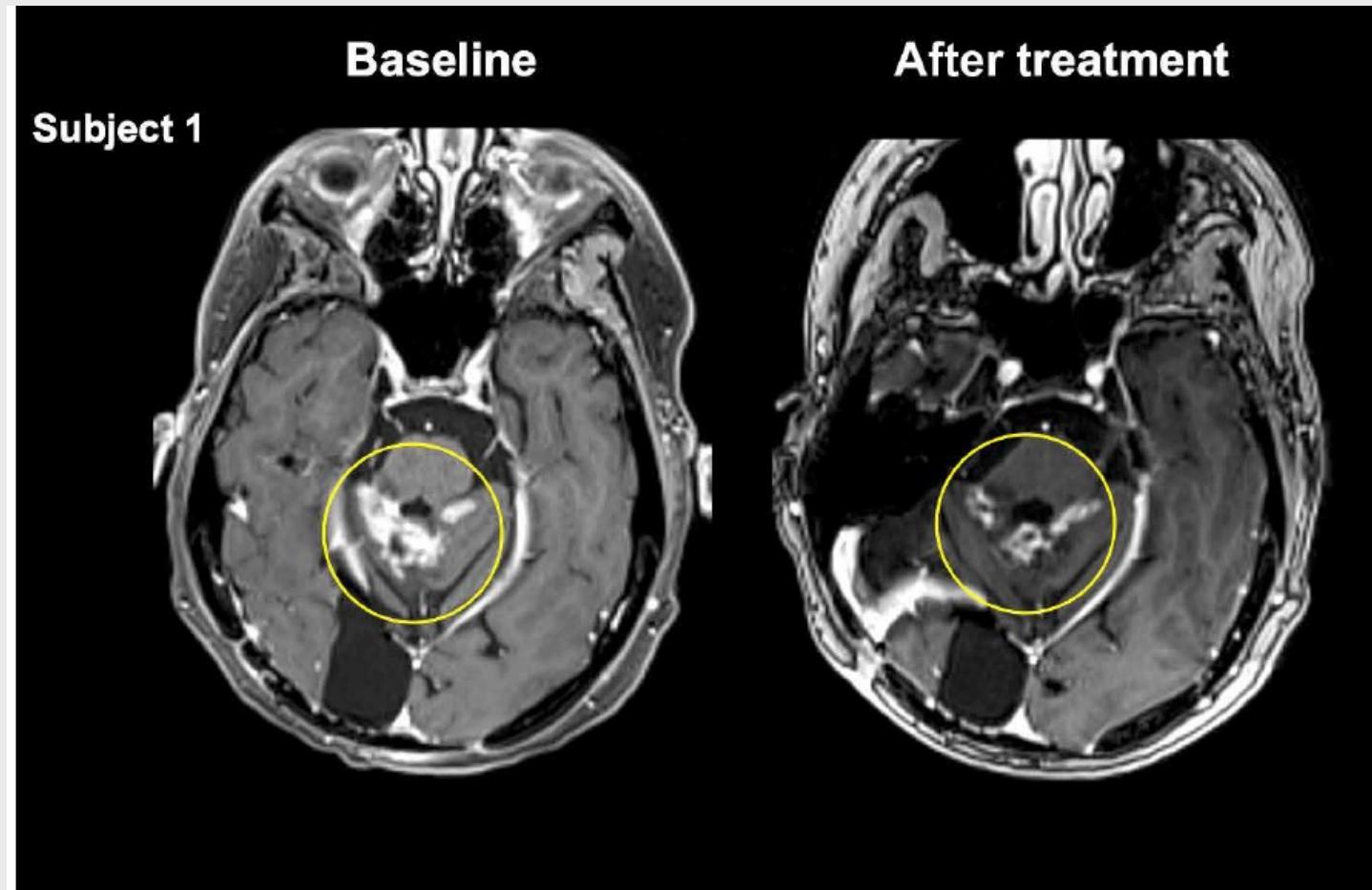


Trastuzumab marqué à l'Indium 111

## A Sonication volume      Cavitation dose      SPECT differences



Trastuzumab marqué à l'Indium 111



## Putaminal Recombinant Glucocerebrosidase Delivery with Magnetic Resonance–Guided Focused Ultrasound in Parkinson’s Disease: A Phase I Study

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Suneil K. Kalia, MD, PhD,<sup>4,8,9\*†</sup> Nir Lipsman, MD, PhD,<sup>1,2,3\*†</sup>  
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Patients with GBA1 mutations

Replacement of lysosomal enzyme  
Glucocerebrosidase (Gcase) slows  
Neurodegeneration

->improve delivery through BBB

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# Traitements dans la maladie de Parkinson

