



Comparison of intraoperative functional brain map obtained with RGB imaging with preoperative functional brain map obtained with functional magnetic Resonance imaging

Anne Josset, C. Caredda, Eric van Reeth van Reeth, L. Mahieu-Williams, Raphaël Sablong, Michaël Sdika, Fabien C. Schneider, Jacques Guyotat, Bruno Montcel

► To cite this version:

Anne Josset, C. Caredda, Eric van Reeth van Reeth, L. Mahieu-Williams, Raphaël Sablong, et al.. Comparison of intraoperative functional brain map obtained with RGB imaging with preoperative functional brain map obtained with functional magnetic Resonance imaging. fNIRS 2021, Oct 2021, London, United Kingdom. hal-03420561

HAL Id: hal-03420561

<https://hal.science/hal-03420561>

Submitted on 29 Nov 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Comparison of intraoperative functional brain map obtained with RGB imaging with preoperative functional brain map obtained with functional magnetic Resonance imaging

A. Josset¹, C. Caredda¹, E. Van-Reeth¹, L. Mahieu-Williams¹, R. Sablong¹, M. Sdika¹,
F. C. Schneider², J. Guyotat² and B. Montcel¹

¹Univ Lyon, INSA-Lyon, Université Claude Bernard Lyon 1, UJM-Saint Etienne, CNRS, Inserm, CREATIS UMR 5220, U1206, F69100, Lyon, France

²Service de Radiologie, Centre Hospitalier Universitaire de Saint Etienne, TAPE EA7423, Université de Lyon, UJM Saint Etienne, F42023 France

³Service de Neurochirurgie D, Hospices Civils de Lyon, Bron, France

Introduction

Context

Non invasive functional brain mapping is an imaging technique used before brain tumor resection to **localize the functional areas** of the patient brain.

f-MRI and **electrical brain stimulation (EBS)** are two complementary clinical tests performed before neurosurgery.

f-MRI tests are performed before the patient craniotomy (**pre-operative gold standard**). **Electrical brain stimulation** tests are performed once the patient cortex is exposed (**intraoperative gold standard**).

Background

Optical imaging can be used to monitor the **brain activity** [1] with the quantification of **hemoglobin concentration changes** ($\Delta[HbO_2]$ and $\Delta[Hb]$).

A device consisting of a **continuous wave white light illumination** and a **RGB camera** is a suitable approach [2].

Objective - Improve the patient care process

We present the methodology to compare **intraoperative functional brain maps** obtained with a RGB camera to **pre-operative or post-operative fMRI maps**.

Material and methods

Experimental paradigm

The **motor skills** of the patient's left hand was tested with **fMRI** and **optical imaging** using a **task-based procedure** (repetitive hand opening and closing). The neurosurgeon also performed **EBS** during the neurosurgery.

Procedures for identifying functional brain areas

Pre-operative procedures:

- MRI anatomical volume (FLAIR sequence)
- fMRI functional map (EG-EPI sequence) and Statistical Parametric Mapping [3]

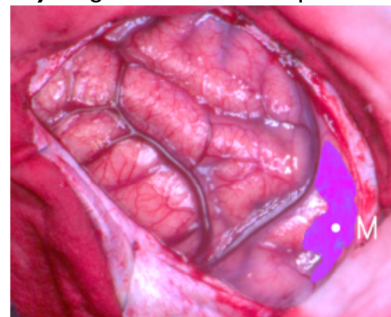
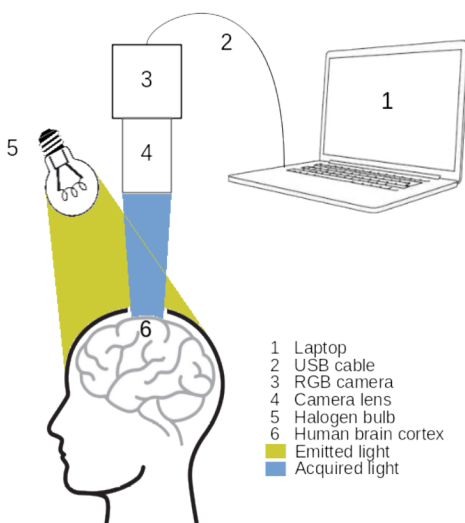
Intraoperative procedures:

- Electrical brain stimulation identifications
- RGB video acquisition, hemodynamics quantification (Modified Beer-Lambert law [2]) and Statistical Parametric Mapping [3,4]

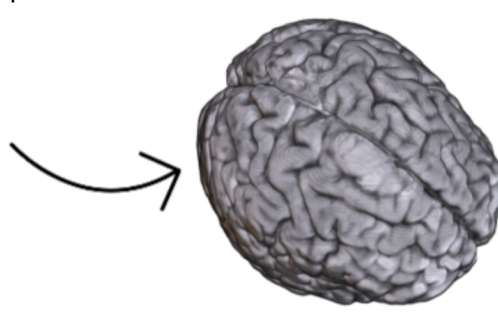
Multi-modality registration procedure

- 1) Segmentation of the cerebral cortex in the pre-operative MRI anatomical volume
- 2) Registration of the fMRI map on the MRI anatomical volume (affine transformation – SPM [3])
- 3) Collection of landmarks in the RGB image and in the MRI anatomical volume
- 4) Computation of the rigid transformation matrix for matching optical and MRI landmarks (least square minimization)
- 5) Registration of the optical map on the MRI volume and of the fMRI map on the RGB image

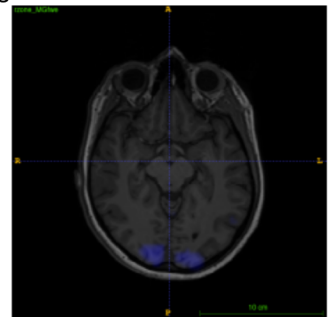
Experimental setup [2]



Intraoperative optical functional map and EBS identification (M)

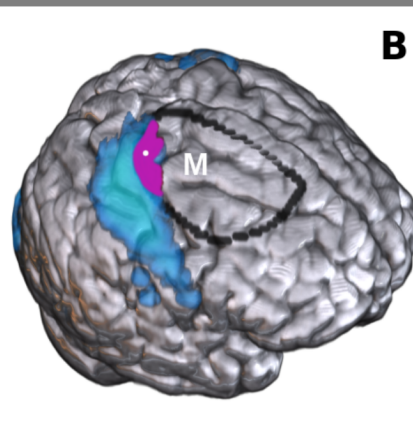
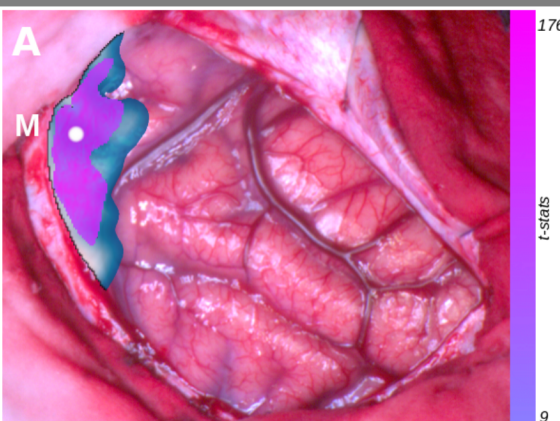


Common referential - Segmented pre-operative MRI anatomical volume



Pre-operative fMRI functional map

Results



B

(A) Intraoperative functional brain maps (in purple) obtained with RGB imaging [2-4]. (B) Pre-operative fMRI functional brain map (in blue).

The optical brain map is represented in purple. The black contour denotes the extent of the surgical window in image A. The letter **M** indicates the motor area identified by EBS.

Good similarity between optical and fMRI functional maps:

$$DICE = \frac{2|fMRI \cap Optics|}{|fMRI| + |Optics|} = 0.69$$

Full overlap of optical map on the fMRI functional map:

$$Overlap = \frac{|fMRI \cap Optics|}{\min(|fMRI|, |Optics|)} = 1$$

Discussion

➔ Automatic registration based on the segmentation of common cerebral structures in MR and optical images

➔ Improving resting-state network detection using RGB imaging [5] by comparing resting-state networks obtained by fMRI

References

- [1] Chance B. et al. Proceedings of the National Academy of Sciences 90, 3770–3774 (1993).
- [2] Caredda C. et al. Neurophotonics 6(4), 045015 (2019)
- [3] Friston, K.J., Ed. Elsevier/Academic Press (2007)

- [4] Caredda C. et al. Proc SPIE (2021)

- [5] Caredda C. et al. Submitted to Diagnostics (2021)

