UNIVERSITE BIOLOGIE BRETAGNE SANTE LOIRE

Année 2021/2022

# THESIS TOPIC

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| **Subject N° (to be completed by the ED):** | **FUNDING:** ☒ **Requested** ☐ **Acquired** | **Funding origin:** |
| Thesis title:<br>**Multimodal analysis of physiological and neurofunctional signs for the optimization of the brain mapping during awake surgery** | | 3 keywords: Machine-learning, awake surgery, brain tumour. |
| Unit / team: LaTIM (UMR INSERM 1101) / IMAGINE team | | |
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Socio-economic and scientific context (approximately 10 lines):
Brain surgery is a real challenge in functional neuroanatomy. Low Grade Gliomas (LGG, WHO grade II) are infiltrating tumors of brain tissue and they usually occur in young patients (average age 38 years). Due to their slow growth and because of the brain plasticity, the majority of patients has a normal or near-normal clinical examination for several years. Surgery is considered to be an effective initial treatment for LGG, i.e., having an impact on the anaplastic transformation delay and an improved survival. When resecting LGG, intraoperative electrical stimulation mapping in an awake condition has proven to be essential, as it allows the identification and preservation of neurological functions, thus maximizing the extent of the resection and decreasing the risk of permanent deficits. However, although techniques have widely evolved these recent years to perform this mapping, they are still insufficient and non-exhaustive and can have a significant impact on the quality of the resection area and therefore on the postoperative results. We want to create an intraoperative monitoring solution allowing the precise determination of the mapping via the intraoperative multimodal analysis of physiological and neurofunctional measurements.

Working hypothesis and aims (approximately 8 lines):
The physiological and neurofunctional responses following brain stimulation are still poorly understood today. As part of this project, we want to better study these effects via a multimodal analysis of various measurements acquired during the intervention and following stimulation in the context of awake surgery. The ultimate goal will be to optimize the mapping and therefore the resection of the tumor thanks to a better understanding of these responses. We therefore want to acquire all intraoperative data such as the (1) physiological data, i.e., the blood pressure, the respiratory rates, the heart rate, the ECG or the temperature, and (2) the data related from the neurofunctional tests carried out during the intervention, in particular for the testing of the of motor, language, or even memory aptitudes. The analysis of all of these signals will highlight new early neurofunctional and/or physiological signs allowing the surgeon to optimize the mapping and therefore the tumor resection.

Main milestones of the thesis (approximately 12 lines):
The PhD thesis will be therefore divided into two main tasks: (1) the collection and structuring of all the physiological and neurofunctional data measured during the intervention and following intracranial stimulation, and (2) the development and validation of an algorithm based on these data to analyse the existing correlations between these signals. A multimodal and synchronous recording system will therefore have to be set up and integrated into the operating room. An RGB-D camera will also be installed in order to acquire all the data related to the neurofunctional tests and for the search of possible face paralysis following stimulation. The multimodal redundancies of all these data will be studied in order to identify new correlations and to highlight new early neurofunctional and physiological signs. To identify such multimodal signs, several challenges associated with these data will have to be overcome, such as the representation of these data in order to fully exploit their complementarity and redundancy.

Scientific and technical skills required by the candidate (2 lines):
The candidate must have strong skills in applied mathematics, image processing, statistical and deep learning, and software development (C++ / Python), and has to show a strong interest in the health field.

3 publications from the team related to the topic (last 5 years):


- Dissaux G, Dissaux B, Kabbaj OE, Gujral DM, Pradier O, Salaün PY, **Seizeur R**, Bourhis D, Ben Salem D, Querellou S, Schick U. Radiotherapy target volume definition in newly diagnosed high grade glioma using 18F-FET PET imaging and multiparametric perfusion MRI: A prospective study (IMAGG). Radiother Oncol. 2020 Jun 21;150:164-171. doi: 10.1016/j.radonc.2020.06.025.
- Cantisano N, Menei P, Roualdes V, **Seizeur R**, Allain P, Le Gall D, Roy A, Dinomais M, Besnard J. Patient-reported functional executive challenges and caregiver confirmation in adult brain tumor survivors. J Cancer Surviv. 2020. doi: 10.1007/s11764-020-00961-0.
- Villa M, **Dardenne G**, Nasan M, Letissier H, Hamitouche C, Stindel E. FCN-based approach for the automatic segmentation of bone surfaces in ultrasound images. Int J Comput Assist Radiol Surg. 2018, 13(11), 1707-1716. doi: 10.1007/s11548-018-1856-x


National and international collaborations :
This topic is part of of new research activity that aims to develop new technological solutions for awake neurosurgery. We are working in close collaboration with the neurosurgery department of the Brest University Hospital, the first center in Brittany to have carried out such interventions. On a national level, LaTIM is also one of the founding members of the LabEx National CAMI (Computer Assisted Medical Interventions), and participates actively in the National FLI (France Life Imaging) infrastructure with the management of actions related to interventional and multimodal imaging.