Decision Support for Inferior Limb Endovascular Revascularization

PhD project supported by the LABEX CAMI, http://cami-labex.fr

Location : TIMC Lab. (University of Grenoble) / LTSI (University of Rennes)

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1. The CAMI context

Medical Interventions (surgery, interventional radiology, radiotherapy) can benefit from a significant boost for progress in terms of patient-specific optimal planning and performance. To fulfil the patient's demands for quality, senior operators demand to see beyond the immediately visible, to be assisted in their real-time vital decisions and to provide access to enhanced dexterity, while junior operators need to "learn to fly" before being left alone, and public health authorities and companies require demonstrations of the medical benefit of innovations.

The Computer Assisted Medical Interventions LABEX (CAMI LABEX) strategic vision is that an integrated approach of medical interventions will result in breakthroughs in terms of quality of medical interventions, demonstrated in terms of medical benefits and degree of penetration of CAMI technology in routine clinical practice.

Among the different actions undertaken in the scope of the CAMI LABEX, 6 to 10 theses starting yearly are to be financed. Subjects dealing with themes within LABEXs scientific field and resulting from collaboration between different CAMI partners will be favored. The following thesis proposal falls within this framework.

2. Context and objectives

Atherosclerosis is responsible for myocardial infarction, strokes, and Peripheral Arterial Disease (PAD). PAD majorly concerns the lower limbs and can lead to major amputations and chronic foot wound that are a major public health matter [1].

Atherosclerotic lesions can cause stenosis, that reduce the arterial lumen or even thrombosis that are occlusion of the artery. When these lesions are responsible for symptomatic PAD, that is lower limb claudication or permanent ischemia with potential foot wound. Explorations of arterial lesions mostly rely on hemodynamic and morphologic analyses with doppler

ultrasound and CT scan. PAD treatment requires medical treatment at all stage and may be completed with surgical revascularization.
In case of surgical revascularization, numerous techniques may be eligible to restore blood flow to the lower limb [2]. These techniques can be either open surgical approaches, as bypass or endarterectomy, or endovascular approaches, as angioplasty, stenting, atherectomy among others. Preoperatively, the surgeon's choice depends on its experience and preoperative clinical and imaging analyses using decision tree models [3]. Procedure's planification is mandatory in order to adapt anesthetic and material choice. Technical success of both techniques is difficult to predict and is a source of multiple interventions and delayed treatment for the patient increasing the risk of amputations and grabatisation.

The objective of this thesis is to help improve the decision of therapeutic choices for endovascular revascularization of the lower limbs based on preoperative information of a given patient. The benefit of this decision support would be twofold: to optimize the choice among the set of therapeutic possibilities and to improve the technical planning of revascularization strategies. Today, the planning of such an operation relies essentially on the surgeon's experience. The development of this decision support tool would be based on the operative results of past interventions and the experiences of several surgeons.

3. PhD subject

Case-based reasoning (CBR) is a field of machine learning based on a model centered on cognitive memory [4]. This technique can adapt solutions of previous problems to solve new ones, using previous cases to propose and justify new solutions. It has already been applied in the field of medicine [5] and even in cardiac surgery, but has not, to our knowledge, been adapted to lower limb vascular surgery. We are currently building a comprehensive database to collect, analyze and format pre-, intra- and postoperative data of PAD cases in order to feed a CBR system and to guide the best therapeutic approaches of a new case based on previous ones.

This approach can also be augmented with preoperative imaging information. The imaging data cannot be directly processed as standard one-dimensional digital data, we want to use the extraction of relevant Radiomics [6] data via a deep learning system.

The proposed approach is to integrate, thanks to the decision support tool that is the CBR, all the parameters that are taken into consideration preoperatively by the surgeon. This includes clinical, paraclinical and imaging data. We also want to integrate the possible impact of experience and potential new parameters such as the analysis from Radiomics. The CBR in PAD treatment techniques will provide decision support and optimization of therapeutic management in order to improve care and limit unfavorable and costly risks of atherosclerotic pathology of the inferior limbs.

4. Qualifications

Master student in the field of information processing and/or biomedical engineering. The expected skills are machine learning, medical data (clinical, biological and imagery) processing and programming. Ability to work in a multidisciplinary environment and a good level of English will also be appreciated.

5. Application

Please send your CV, a cover letter and 2 references to the address: Celine.Fouard@univ-grenoble-alpes.fr with the following subject: [phd candidate]: “Decision Support for Inferior Limb Endovascular Revascularization”

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