Dynamic evaluation of ankle joint and muscle mechanics in children with spastic equinus deformity due to cerebral palsy

Internship proposal supported by the LABEX CAMI, http://www.cami-labex.fr/

Internship location: LaTIM (Brest) Lab.

Internship supervisors:

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1. The CAMI context

Medical Interventions (surgery, interventional radiology, radiotherapy) can provide a significant boost for progress in terms of patient-specific optimal planning and performance. To fulfill patient's demand for Quality, Senior Operators demand to see beyond the immediately visible, to be assisted in their real-time vital decisions and to accede to enhanced dexterity, while junior operators request to "learn to fly" before being left alone, and Public Health Authorities and companies require demonstration 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 a breakthrough 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, about 10 internships are to be financed yearly. The following internship proposal deals with themes within LABEX's scientific field.

2. Background

Equinus is the most common deformity in children with cerebral palsy (CP). Spastic equinus is typically defined as the inability to dorsi-flex the foot above plantigrade, with the hindfoot in neutral position and the knee in extended position. Approximately 90% of the deformities in cerebral palsy occur in the ankle and foot region alone with the incidence of equinus being around 75%. Spastic equinus exhibits poor muscle control and muscle weakness around ankle and foot, resulting in bone deformities during growth and gait abnormalities. Specifically, a dynamic tightness or fixed contracture of the calf muscle disrupts the normal heel, ankle and forefoot rockers and impairs the function of the foot. Equinus deformity induces abnormal gait patterns decreasing the stability in stance, causes a loss of the smooth translation of the body over the foot and often leads to an inadequate clearance of the foot during the swing phase of the gait.

3. Detailed subject

Equinus ankle is the most common orthopedic deformity in children with cerebral palsy (CP) and has important consequences for the growth of affected limbs and gait. Although surgery is the most recommended option for treating equinus, the rate of post-operative recurrence is very high (48%).

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One of the main reasons is the lack of understanding of joint and muscle biomechanics i.e what is mechanically occuring in the bones, muscles and tendons in case of equinus. The dynamic MRI imaging techniques allows an evaluation during movement in three dimensions of space with a high accuracy (<1mm). We believe that these dynamic techniques that would be used for the first time in France would help greatly in understanding the mechanisms involved in the equinus of children with CP. To do so, 13 children with cerebral palsy and equinus will be compared with 13 children of the same age. They will benefit from dynamic MRI of the ankle and a 3D gait analysis using an optoelectronic system (light reflecting markers). The comparison will characterize the abnormal movements underlying the ankle bone, abnormal tension of the Achilles tendon and also the calf muscle elasticity. These intrinsic data will be linked with the quality of the gait. In other words, the anatomical problem will be linked to the functional problem, which concern more the children and parents. This study will thus provide essential information for researchers, surgeons and clinicians and will thus improve medical and surgical therapies of equinus in CP. The innovative tools developed in this study can also be applied to other joints and / or other pathologies.

Required knowledge

The candidate must have knowledge in image and/or video processing, as well as in physics of sensors.

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