

Internship proposition

Academic Year: 2025-2026

Acronym: PARA EOS

Project title: Dynamic Assessment of Lumbar Paravertebral Muscle Stiffness

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Project description:

Lumbar spine disorders, including nonspecific low back pain, spinopelvic imbalance, and degenerative conditions, are chronic, progressive, and unpredictable diseases that represent a major public health concern. The role of **paravertebral muscles** in these pathologies remains poorly understood, although they are likely involved in both disease onset and progression. Evidence suggests that spinal stability depends on the **elastic balance** of these muscles, and that stiffness changes may contribute to lumbar disorders.

Ultrasound elastography enables quantification of muscle stiffness (shear modulus) and estimation of active and passive muscle forces. Preliminary studies at Paris-Saclay, Bicêtre Hospital, and ENSAM have demonstrated the reproducibility of stiffness and the influence of posture on paravertebral elasticity. Elasticity correlates with neuromuscular activity and can reflect coordination during isometric extension. However, static measurements at rest or contraction are highly variable and do not capture the **dynamic biomechanical response** of muscles under load. **Dynamic elastography** is therefore required.

We hypothesize that elastography can detect **paravertebral elastic imbalance** and may serve as a **biomarker of lumbar disease severity**. Developing dynamic elastography protocols is essential for clinical translation and for quantifying the elastic response of axial musculature during active and passive lumbar flexion across different back morphotypes.

Specific Aims

1. **Develop a dynamic ultrasound elastography protocol** for quantifying elasticity of multifidus, erector spinae, and psoas muscles in prone and standing positions.
2. **Assess postural modifications** (lumbar lordosis variation induced by heel lifts) and define muscle behavior “profiles” associated with back morphotypes.
3. **Integrate motion analysis** (sacrolumbar angle from inertial units) with elastography measurements.
4. **Correlate muscle mechanical properties with sagittal alignment** measured by EOS imaging.

This project will initiate a **data collection pipeline**, enriched by sagittal imbalance patients (operated and non-operated) from Bicêtre. It constitutes a **feasibility study** supporting the establishment of a dynamic elastography protocol and providing preliminary data for an **ANR funding application**.

Elastography acquisitions will be performed at ENSAM, following standardized EOS protocols (standing AP, standing lateral, 20° and 45° lumbar flexion, with/without heel lifts). Multiple **30-second dynamic elastography protocols** will be repeated for reproducibility and clinical applicability. Motion analysis will accompany all acquisitions.