Bell Burnell Graduate Scholarship Scheme – Physics Project

PROJECT TITLE: Characterising spinal disc stiffness and mechanics in vivo

Lead Supervisor: Jude Meakin

Profile Webpage: https://experts.exeter.ac.uk/18779-jude-meakin

Co-Supervisors: TBC

Project details: Spinal disorders are a dominant cause of pain, disability and low quality of life throughout the world. The economic burden of spinal disorders is substantial, with costs of approximately £10-100 billion per year in Europe and the US. International guidance highlights the urgent need to address this burden through cost-effective management and improved diagnosis and treatment. Our ability to meet this need, however, is impeded by the limitations of methods currently available for evaluating the biomechanics of the spine in vivo.

Degeneration of the spinal discs is frequently implicated in spinal disorders, either as a cause or a consequence; however, we lack effective methods for establishing mechanistic links between observed disc degeneration and the mechanics of the discs and spine. Developing new methods to assess the stiffness and mechanics of spinal discs in vivo will enable us to determine the causal factors underlying spinal disorders and propose biomarkers that can, for example, stratify patients for specific treatments.

The proposed project aims to develop and test new methods for characterising the stiffness and mechanics of the intervertebral discs in vivo. The project will capitalise on recent advances made at the Universities of Exeter and Bath, UK in spine and disc biomechanics, and utilise an existing dataset of mechanical and magnetic resonance imaging data.

Our first objective will be to identify a method for characterising the stiffness of the discs in a way that is comprehensive enough to capture the complicated mechanical behaviour of the discs in six degrees of freedom, whilst being pragmatic enough to be used in real-life scenarios. An existing set of mechanical test data will be used, which comprises kinematic data from sixteen human specimens tested with and without the facet joints. Using the data without facet joints, a comparison will be made of two potential methods for characterising the stiffness (one involving computational modelling and one involving a viscoelastic model). The chosen method will then be applied to the whole dataset to determine the full stiffness matrix for all sixteen discs.

The second objective will be to determine how the stiffness of the discs can be predicted from magnetic resonance imaging data. In addition to the mechanical test data, the sixteen human specimens have also been previously imaged in a magnetic resonance scanner to provide data that includes T1, T2 and T2* relaxation maps. Relaxation times are influenced by the physical and biochemical properties of tissues, and will therefore relate to their mechanical properties. We will determine the relationships between the relaxation times and stiffness parameters for each disc and learn how to predict the stiffness using the image data. The accuracy of the predictions will be assessed using a leave-one-out approach.

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The third objective will be to apply the methods to determine how well forces and moments can be determined from real-world data. The first stage of this will be to evaluate the accuracy of predicted kinematics using an additional part of the in vitro mechanical testing dataset that mimicked the kinematics of spinal motion in human participants performing a range of different daily activities. This involves forces and motion across multiple axes and so will provide a realistic test of the methods.

Project specific entry requirements: Degree in Physics or Engineering or similar.

Potential PhD programme of study: PhD Physics

Location: Physics Building, Streathamn Campus, Exeter

Please direct project specific enquiries to: Jude Meakin (J.R.Meakin@exeter.ac.uk)

Please ensure you read the entry requirements for the potential programme you are applying for.

To Apply for this project please click on the following link - **APPLY HERE**

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