Multi-scale adaptive model of the bone-cartilage unit in the rat knee

Created on: 08-10-2019 - Last modified on: 08-11-2019

SCOPE OF THE METHOD

The Method relates to	Animal health, Human health
The Method is situated in	Basic Research
Type of method	In silico
This method makes use of	Animal derived cells / tissues / organs

DESCRIPTION

Method keywords

multiscale modeling

rat

knee

bone-cartilage unit

multibody dynamics

finite element modeling

adaptive model

joint loading

Scientific area keywords

biomechanics

osteoarthritis

bioengineering
Computational pathology
simulation engineering
modeling

Method description

This work will be based on data describing the rat hindlimb kinematics obtained by X-Ray Reconstruction of Moving Morphology (XROMM) and ground reaction forces following destabilization of the medial meniscus (DMM) and running. These data will be analyzed with multi-body dynamics to estimate the multi-axial mechanical environment in the knee (organ scale). The multi-axial loading estimates will be combined with adaptive models of the articular cartilage and bone (tissue scale), in order to create a multi-scale adaptive model. The resulting multi-scale adaptive model of the cartilage-bone unit in the rat knee will be validated with experimental data from small animal experiments. After validation, this computational model will be used to predict the progression of joint degeneration after DMM in the rat.

Lab equipment

Instrumented force plate ;
XROMM (University of Antwerp) ;
Opensource software OpenSim ;
FEA software Abaqus.

Method status

Still in development

PROS, CONS & FUTURE POTENTIAL

Advantages

Altered loading is widely accepted but poorly understood as a driver of OA in animal models. The multi-axial loading conditions in the knee are yet currently undocumented, due to the difficulty to measure joint mechanics without disrupting it. This computational model will contribute to a fundamental understanding of the mechano-responsiveness of the bone-cartilage unit in normal and altered loading.

Such model can in the long term be adapted to predict the outcomes of OA interventions in patients (surgery, exercise). In the short-term, it will help elucidate the process of OA progression and contribute to the “Three Rs” in animal research (replacement, reduction, refinement).

Challenges

The method is currently in development.

REFERENCES, ASSOCIATED DOCUMENTS AND OTHER INFORMATION

References

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Associated documents

PARTNERS AND COLLABORATIONS

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Coordinated by

Financed by