

# Multi-scale adaptive model of the bonecartilage unit in the rat knee

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### **SCOPE OF THE METHOD**

The Method relates to	Animal health, Human health
The Method is situated in	Basic Research
Type of method	In silico

#### DESCRIPTION

#### Method keywords

multiscale	modeling
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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

Pereira et al. (2015) J. of The Royal Soc. Interface 12(110):20150590 Orozco et al. (2018) Sci. Reports 8(1) 1-16 Goldring & Goldring (2016) Nat Rev Rheumatol. 12(11):632-644 Burr & Gallant (2012) Nat Rev Rheumatol.8(11):665-673 Stender et al. (2017) Comp. Biomech. Biomed. Eng. 20(3) 319-331 Britzman et al. (2018) Scientific Reports 8(1):1-8

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