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# Integration of biomechanical and biophysical *in silico* models to explore the complexity of musculoskeletal diseases over multiple scales

## Short Bio:

Dr. Noailly's PhD on the creation and assessment of numerical models for analysis of the functional biomechanics of the lumbar spine was awarded the prize of the best PhD thesis in Engineering at the Universitat Politècnica de Catalunya, Barcelona, Spain. In 2007, Dr Noailly went first to the AO Foundation in Switzerland, and then to the Eindhoven University of Technology in the Netherlands, in order to work in computational mechanobiology with a postdoctoral intra-European Marie Curie fellowship. In 2009, he went back to Barcelona with a Marie Curie Reintegration Grant and since 2012 he is the principal investigator in the Biomechanics and Mechanobiology group at the Institute for Bioengineering of Catalonia (IBEC). He is also IBEC's legal representative of the Virtual Physiological Human Institute, and the current president of the National Spanish Chapter of the European Society of Biomechanics.

## Abstract:


Despite important advances in the development and in the use of both diagnostic and treatment tools in medicine, treatments of common musculoskeletal diseases such as low back pain an osteoarthritis have still very limited efficiency. Over the last decades, numerical models in biomechanics have allowed improving our understanding of musculoskeletal conditions, which is partly due to the explorations of the mechanisms that possibly underlie specific symptomatic conditions. Yet, computational biomechanics has difficulties to spread beyond the borders of academic research, mainly because the translation of mechanical predictions into biology-based rationales is still unclear.

The group of Biomechanics and Mechanobiology at IBEC strongly focuses on modelling solutions that pave the way to mechanistic descriptions of couplings through which organ biomechanics, tissue multiphysics, and cell biophysics interact and affect the fate of musculoskeletal tissues. In this sense, particular efforts were made to describe the lumbar spine system, down to cell processes that may occur in the different subtissues of the intervertebral disc. Modelling concepts were also applied to the exploration of intervertebral disc prostheses, of hip coxarthrosis, and atherosclerosis. At the cell level, stochastic processes can be simulated to represent the biological diversity of patients.

These explorations were confronted to both literature data and clinical records, and revealed the potential of in-silico studies to confirm or to infirm the likeliness of specific clinical hypotheses that would be extremely difficult to explore otherwise. The research developed also addressed the problem of model verification/validation in function of different sets of theoretical hypotheses. All in all, such information is fundamental for an educated use of simulation results to build new concepts for improved diagnosis and prevention.


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