NATALI URIBE ACOSTA

PHD STUDENT | PROGRAM 1
ARC TRAINING CENTRE FOR JOINT BIOMECHANICS

PhD duration: July 2021 - July 2024

My interests: product development, 3D printing, computational modelling, biomechanics, artificial organs and biomaterials, finite element modelling, prosthesis and osteosynthesis material design. I am interested in continuing with a project that help me with my career in research working in a multidisciplinary team.

Collaborators: Industrias Medicas Sampedro

BBE (Universidad de Antioquia Colombia),
MBE (Universidad EIA Colombia)

Supervisors:
A/prof. Saulo Martelli, Prof. Peter Pivonka, Doctor Dermot O'Rourke

PROJECT OVERVIEW

Project Title: Statistical shape and appearance model of the proximal femur to develop a parametric finite element model.

THE PROBLEM

Information on bone biomechanics during physical activities is important for studying bone adaptation, bone mass reduction, and the effect of physical activities on healthy bone preservation, especially when the bone is affected by diseases such as osteoporosis, where reduced bone mineral density (BMD) and microarchitectural deterioration are present. Commonly, the development of statistical shapes and appearance models (SSAM) does not include data that involve the population range because they are developed using aged populations, and in most cases use the DXA technique to obtain the images.

Why does the parametric finite element model obtained from the SSAM require more research?
My research aims to develop a SSAM of the proximal femur. For these generated models to be useful, the model will generate FE meshes that are suitable for Finite Element (FE) calculations that will help to study the mechanical changes in the bone during physical exercise, taking into account how variations in the mechanical conditions of the human bones may be related to geometry or bone distribution during daily activities. Finally, if we know how physical exercise drives mechanical stimulus in a variety of bone shapes and densities, we can predict bone adaptation for better patient outcomes.

What is the significance of this research?
The SSAM that integrates FE analysis will assess the advantage of physical exercise to stimulate bone osteogenesis across the population, developing a method for assessing changes of the volumetric bone mineral density and femoral strength and establishing correspondence between bones.

HYPOTHESIS

The statistical shape and appearance model that I am developing could assist in understanding how the variation in bone and physical exercise work together, to predict the hip mechanical behavior.

PROJECT AIMS

- Develop a statistical shape and appearance model of the proximal femur bone using a set of HR-pQCT scans providing information of bone geometry, density distribution and microstructural organization in the whole adult population.
- Determine the deformation of the hip while executing a range of different motor tasks.
- Relate variation of motor demand, bone shape, density distribution and microstructural organization and bone deformation.

OUR SOLUTION & EXPECTED OUTCOMES:

the most important step in this research are the generation of statistical shape and appearance model, using a complete process to convert tomographic data into realistic proximal femur models. Once constructed it will be used to generate a large number of models by sampling through the variability it presents, for the model to be useful, the model will generate FE meshes that are directly suitable for FE calculations that will help to predict femoral neck strength under load and investigate the effect of femoral anatomy on its strength. Overall this can create a tool application that provides better medical treatments in people with osteoporosis, or in healthy older people that want to preserve good quality bone mineral density.

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