FRANÇOIS BRUYER-MONTÉLÉONE

PHD STUDENT | PROGRAM 1
ARC TRAINING CENTRE FOR JOINT BIOMECHANICS

PhD duration: September 2022 to September 2025

My interests: Computational modelling, artificial organs and biomaterials. I love working in a multicultural environments on cross-fields projects. I am interested in long-term product testing regarding the stability of the implants, in new prosthesis designs and implementation/improvement in surgical procedures.

Previous Collaborators: 3S ORTHO, Stryker

MEng (Université de Technologie de Compiègne)
Supervisors:
Prof. Peter Pivonka, A/Prof. Saulo Martelli, Prof. Graham Kerr, A/Prof. Devakar Epari, Prof. Syn Schmitt, Adj. A/Prof Ashish Gupta

PROJECT OVERVIEW

Project Title: Assessment of the effects of shoulder complex anatomy on glenohumeral joint stability using musculoskeletal modeling

THE PROBLEM

Shoulder surgery has the highest revision rates among other joint surgeries. Musculoskeletal (MSK) models can improve the understanding of the shoulder's biomechanics as some parameters cannot be measured directly. Their predictions can help identify pathological causes, provide optimal treatment techniques and implement strategies to avoid pathologies and improve functions. Currently, MSK models are based on single body anatomies which do not provide sufficient information when investigating the shoulder morphological variety in a typical human population and hence thoroughly inform on the benefits of a surgical procedure to a patient's body.

Why do the effects of complex shoulder anatomy on glenohumeral joint stability require more musculoskeletal modeling research?
MSK modelling can be used to estimate internal joint loading with high accuracy and simulate joint stability and motion. The stability of a joint defines its range of motion (ROM) and is secured by its environment (articular surface, ligaments and muscle tone). Without stability, joints can grind together leading to wear and tear throughout the years which could lead to damage and corrective surgery. The shoulder allows the largest ROM. One of the most common problems of the shoulder arises from the glenohumeral (GH) instability which frequently leads to anterior shoulder dislocation (ASD). Recent MSK studies have provided details on the impacts of gold-standard surgical procedures like the Latarjet to treat ASD. Nonetheless, it is not clear how the different effects overall contribute to shoulder joint stability.

How can modelling the effects of shoulder complex anatomy on glenohumeral joint stability help ?
Developing a novel musculoskeletal (MSK) modelling platform for ASD patients can help simulate surgical scenarios and help track efficiency of shoulder joint rehabilitation procedures. Based on this questions related to the effects of (i) bony variations, (ii) attachment of muscle-tendon units, (iii) muscle functionality on shoulder joint biomechanics and (iv) surgical procedure outcomes can be addressed.

HYPOTHESIS

By utilizing accurate MSK models of the shoulder it is possible to assess different effects of surgical interventions. To do this, the high variability in human shoulder anatomy including bony anatomy and muscular parameter (muscle path, pennation angle, number of fibers, etc.) variation needs to be considered.

PROJECT AIMS

The objective of this PhD research is to develop a MSK model of the shoulder complex that will represent the differences in human morphology to investigate GHJ stability. To achieve this goal, this research will be divided into three different projects:

1. Development of a shoulder statistical shape model in the context of glenohumeral joint stability investigation
2. Shoulder muscular attachment site variability effect on MSK model predictions: a convergence analysis
3. Assessment of a gold-standard surgical intervention for ASD in a specific cluster of patients: case of the Latarjet procedure

OUR SOLUTION & EXPECTED OUTCOMES:

The experiments resulting in this PhD will give a new prospect of shoulder biomechanics for patients with ASD conditions. Using this comprehensive experimental-simulation approach, one can address problems such as surgical recurrency in the shoulder joint. Furthermore, efficient rehabilitation procedures strengthening selected muscles of the shoulder can be assessed which allows customizing rehabilitation for patients. Eventually, by understanding the benefits of muscle tendon transfers and co-contracting strategies for different body anatomies optimal surgical techniques can be developed as part of subject-specific treatment.

ORCID 0000-0002-8915-2419
f2.bruyermonteleone@hdr.qut.edu.au
@François Bruyer-Montéléone

Joint Biomechanics Training Centre