YILAN ZHANG

PHD STUDENT | PROGRAM 1
ARC TRAINING CENTRE FOR JOINT BIOMECHANICS

PhD duration: February 2021 - August 2024

My interests: Product Development / Research Engineering (R&D positions), Quality Assurance roles, or roles related to coding & data analysis.

Industry Impact: Data on the anatomy and architecture of the human shoulder muscles are needed to understand shoulder biomechanics, the functional consequences of muscle pathology, and to predict or evaluate the outcomes of shoulder surgery. My research better informs surgeons on the impact of shoulder surgeries (e.g., shoulder arthroplasty and tendon repair) and provides insights on the influence of difference surgical techniques on functional improvements, for better pre-operative planning. It can also help medical device companies to develop patient-specific shoulder replacement implants.

BEng (Hons, UNSW)

Supervisors:
Dr Bart Bolsterlee, Robert Herbert & Prof Lynne Bilston

PROJECT OVERVIEW

Project Title: Image-based anatomical modelling of human shoulder muscles

THE PROBLEM

Why is it important to determine the subject-specific shoulder muscle architecture data?

- Pre- and post-operative conditions of the shoulder muscles are key factors affecting surgical outcomes, as these muscles work together to dynamically stabilize the shoulder complex.
- Muscle architecture can change with exercise, ageing and disease. Quantitative measurement of muscle- and subject-specific architecture parameters is critical for interpreting anatomical adaptations and understanding the skeletal muscle structure-function relationships.

Why does shoulder muscle architecture need more research?

- Little is known about the in vivo architecture of the human shoulder muscles due to the limitations of ultrasound imaging.
- In clinical settings, quantifications of human shoulder architecture are not viable due to the difficulty in image acquisition and post-processing.

How can image-based anatomical modelling help?

- DTI, an MRI-based technique, has been validated to be a viable and repeatable method to provide in vivo, high-resolution measurements of whole muscle three-dimensional architecture. This provides an opportunity to generate subject-specific architectural models of whole shoulder muscles.
- By investigating the relationship between muscle surface geometry and internal muscle architecture, the muscle architecture can be predicted based on muscle geometries reconstructed from anatomical MRI scans. This omits the need for additional scan time, labor force and expense.

HYPOTHESIS

Anatomical MRI and DTI scans will be used to build integrated anatomical model on human shoulder muscles, including the surface and internal architecture of key shoulder muscles. This provides an opportunity to noninvasively study shoulder muscle structure-function relationships in patients.

PROJECT AIMS

1. Develop MRI protocols and analysis pipelines for reconstruction of shoulder anatomy from anatomical MRI and DTI scans.
2. Build population-representative 3D statistical shape models of geometries of key shoulder muscles and bones.
3. Build population-representative 3D fiber orientation (muscle architecture) models of key shoulder muscles.
4. Investigate the relationship between muscle surface geometry and internal fiber orientation (muscle architecture) of key shoulder muscles.

OUR SOLUTION & EXPECTED OUTCOMES:

Population-representative 3D models, which combined both surface geometries and internal architectures of key shoulder muscles, will be built. This can be used to develop anatomically realistic computational models of the human shoulder and help evaluate (patho)physiological adaption of shoulder muscles. In clinical settings, this information is expected to help in pre-operative planning to mitigate joint instability after arthroplasty, and the evaluation of compatibility of various musculotendinous transfers around the shoulder.

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