A PATIENT-SPECIFIC MUSCULOSKELETAL MODEL OF TOTAL KNEE ARTHROPLASTY TO PREDICT IN VIVO KNEE BIOMECHANICS

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ABSTRACT

Musculoskeletal (MS) models are useful to gain information on *in vivo* biomechanics that would be otherwise very difficult to obtain. However, before entering the clinical routine MS models must be thoroughly validated. This study presents a novel MS modelling framework capable of integrating the patient-specific MS architecture in a very detailed way, and simultaneously simulating body level dynamics and secondary knee kinematics. The model predictions were further validated against publicly available *in vivo* experimental data.

The bone geometries were segmented from CT images of a patient with an instrumented Total Knee Arthroplasty (TKA) from the "Grand Challenge Competition to Predict *In Vivo* Knee Loads" dataset. These were inputted into an advanced morphing technique in order to scale the MS architecture of the new TLEM 2.0 model[1] to the specific patient. A detailed 11-DOF model of the knee joint was constructed that included ligaments and rigid contact. An inverse kinematic and a force-dependent kinematic technique[2] were utilized to simulate one gait cycle and one right-turn trial. Tibiofemoral (TF) joint contact force predictions were evaluated against experimental TF forces recorded by the TKA prosthesis, and secondary knee kinematics against experimental fluoroscopy data.

The coefficient of determination and the root-mean-square error between predicted and experimental tibiofemoral forces were larger than 0.9 and smaller than 0.3 body-weights, respectively, for both gait and right-turn trials. Secondary knee kinematics were estimated with an average Sprague and Geers' combined error as small as 0.06.

The modelling strategy proposed permits a high level of patient-specific personalization and does not require any non-physiological parameter tuning. The very good agreement between predictions and experimental *in vivo* data is promising for the future introduction of the model into clinical applications.

REFERENCES

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