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Introduction

Total Knee Arthroplasty (TKA) is a common orthopaedic procedure with estimations for increasing demands in the coming decades. Yet, TKA exhibits a high dissatisfaction rate. These highlight the one-fits-all approach's weaknesses that may not satisfy the specific patient's needs. The personalisation of TKA has become a major stake in the pre-operative planning process. Digital twins in clinics enable to reach levels of personalisation of patients' anatomies that were not possible with procedures based on medical imaging. The patella's position and collateral ligaments' elongations, which appear to have a significant impact on the success of TKA, could be estimated *in vivo* from numerical simulation methods. Our team developed an easy-to-use simulation platform to visualise the personalised knee in 3D and estimate ligaments' elongations and patella's kinematics. The personalised knee model is created from a generic multibody model using only Computed Tomography (CT) images.

This study aimed to evaluate the generic model predictions using *in vivo* Magnetic Resonance Imaging (MRI) data.

We hypothesised that a multibody 3D model of the knee joint can be used to estimate the patella's kinematics and ligaments' laxity during passive flexion/extension.

Material and method

The generic model was designed using the combined FE and multibody framework with one healthy subject (40 years old, 94 kg, 1.73 m) low-energy CT scans[1]. Ligaments' material parameters were set according to literature data on *ex vivo* tension tests. The same subject underwent five non-weight-bearing MRI sessions with increasing knee flexion angles, up to 137.5°. MRI segmentations were performed to assess the bones and collateral ligaments' positions. A displacement was imposed to the femur for each angle to coincide with MRI data. The patella's position and the collateral ligaments' elongations were extracted from the simulations and compared to the MRI segmentations.

Results

The mean ligament elongation error was 5 %. The errors increased with the flexion angles. The mean error of the patella position was 4 mm. The proximo-distal axis was the least precise for intermediate angles, while the antero-posterior axis was the least accurate for large angles.

Discussion
The model can predict clinically relevant data. Predicted data can then be used to compare the relevance of different surgical plans considering patient's specific anatomy. This study is a first step towards the standardization of personalised TKA planning.

Conclusion
Proof level III.