Can Patient-specific Computer Simulations of the Hip Joint Improve Osteoarthritis Diagnosis?

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Osteoarthritis is a common disease that decreases the quality of life for those living with the disease. Early detection is important to ensure right treatment for the patients. Small changes in how forces are distributed within the hip can damage the cartilage and over time lead to osteoarthritis. A more personalized assessment can improve the quality of life for the patients living with the disease through early detection and ensure right treatment.

With every step we take, the hip joint experiences forces several times greater than our body weight during daily activities such as walking and running. Cartilage within the hip joint acts as a cushion between the two bones (the femur and the pelvis) and allows them to glide smoothly against each other. Changes in how the forces are distributed within the hip alter how the hip is loaded. This can in turn result in local alterations in force distribution and cause damage to the cartilage. Later on, the damage can develop into osteoarthritis, where the cartilage and underlying bone breaks down.

A combination of motion data (such as walking and running) and computer models can simulate how forces are distributed within a patient's hip. These simulations can predict how forces affect the cartilage and thereby support detection of osteoarthritis in the hip joint.

In this master's thesis, a pipeline has been developed to evaluate how forces are distributed within the hip joint depending on how the hip is loaded during walking and running. Based on this motion data, computer models of bones and muscles estimated forces acting on the hip. These forces mimic how load is applied throughout these movements. Parallel to this, a computer model of the hip joint was developed to simulate walking and running. The estimated forces were applied to this computer model to predict how the cartilage is affected based on the two loading scenarios. The effect of the forces acting on the cartilage could thereby be studied throughout walking and running, including where the greatest forces occur. These simulations showed that the cartilage experiences greater forces during running than walking.

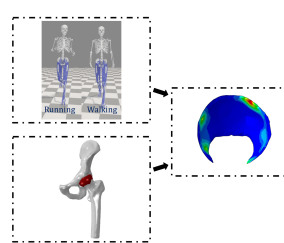

Fig. 1. A schematic of the workflow for this thesis.

The pipeline opens the doors to use loading conditions specific for each patient's hip. In the future, these simulations can help doctors in diagnosing osteoarthritis and support personalized treatment, which can improve patient's quality of life.