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EFFECT OF BODY-MASS-INDEX OF VIRTUAL PATIENTS ON THE WEAR OF LUBRICATED HIP JOINTS IN GAIT CYCLES - A NUMERICAL STUDY

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Summary: This work aims to provide a numerical tool to predict the wear performance of hip joint replacements considering more specific patient groups in terms of the body-mass-index (BMI). Total Hip Replacement (THR) is generally a highly successful treatment for late stage hip joint diseases and wear, however, wear continues to be one of the major causes of THR's failure. In this paper, a numerical wear simulation of metal-on-polyethylene hip replacements is presented, under the walking conditions of various BMI. The wear model is fully coupled with the mixed lubrication regimes (boundary lubrication and elastohydrodynamic lubrication), rather than a dry contact used in most of other studies of wear modelling in the literature. The mechanical wear is described by an adapted Archard wear formula by introducing a power term of the 'lambda ratio' (the ratio of film thickness to surface roughness). Non-Newtonian shear-thinning properties of the synovial fluid is addressed in the model. The loading and motion applied on the hip joint bearing surface in gait cycles of virtual patients with both high and low BMI are considered.
The numerical wear simulation is carried out until steady-state wear rate is observed. During this procedure, the change of worn profiles are updated regularly. The two stage wear is found, i.e., the running-in wear in the beginning with high wear rate followed by a steady-state wear after around one million cycle with much lower wear rate. The wear evolution process (wear scar profiles and wear depth variation) are presented in the results. The predicted wear are compared under different BMI values and the effect of the different loading and motion patterns are discussed. This work could provide an important numerical tool to aid the design of hip joint replacements towards more specific patient or patient groups.