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PREDICTION OF OSTEOPHYTES RELEVANCE IN HUMAN OSTEOARTHRITIC FEMUR HEAD FROM LOAD PATTERN REARRANGEMENT SIMULATIONS: AN INTEGRATED FEM STUDY

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Summary: Introduction: Osteoarthritis (OA) is the most common degenerative joint disease and it is mainly characterized by articular cartilage damage, synovial fibrosis and osteophyte formation. Osteophytes are osteo-cartilaginous outgrowths that involve the bone structure of osteoarthritic joints. In this study we analyzed how osteophytes evolution leads to a rearrangement of the stresses and strains within the subchondral trabecular bone.
Methods: A 3D, isotropic, homogeneous and linearly elastic model of the proximal half of the human femur head was implemented from radiographic images. The osteophytes formation is achieved by introducing different loading distributions that mimic concentrated loads on the femur head surface. By means of the finite element analysis (FEA), we explored the circumstance that osteophytes growth alters the physiological load pattern in such a way that large zones of reduced load can cause resorption and the formation of bone cysts (geodes), surrounded by areas of overstimulated tissue (eburnation).
Results: The outcome of the FEA provides Von Mises Stresses (VMs) and strain energy density (SED) for four different scenarios (Healthy, Early, Intermediate and Advanced Osteoarthritis) characterized by different osteophytes spatial distributions on the femur head. According to our simulation, osteophytes growth lead to abnormal contact between bony extremities and alters loading conditions in the femoral head which in turn will induce the re-arrangement of trabecular subchondral bone. The simulations of VMs and SED were compared to clinical studies to validate the effectiveness of the model.
Conclusion: The parametric study conducted can result particularly useful not only for the clinical assessment of bone failure but also for the design of patient-specific scaffold, especially if combined with 3D-printing technique.