ArthroLube: Injectable lubricants for prosthetic joint implants

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Abstract

Wear problems of bearing materials for prosthetic articular joints, such as total hip arthroplasty (THA) or total knee arthroplasty (TKA), have long been recognized as a major cause of degradation and failure of the implants. Thus, improvement of anti-wear properties of implant materials is a key requirement to improve lifetime of prosthetic articular joints. To date, efforts to solve this problem have been directed towards the development and application of new materials with superior anti-wear properties. The present study proposes to solve this problem by administering external lubricants to prosthetic articular joints. This approach is primarily based upon recent development of various lubricant additives that improve anti-wear properties even in aqueous environment. With an aim to reduce the wear of ultrahigh molecular weight polyethylene (UHMWPE), external lubricants were formulated by dissolving commercial amphiphilic copolymers in aqueous buffer solution. Pin-on-disk tribometry and hip joint wear simulator (ISO 14242-1) were employed to assess the frictional and wear properties of UHMWPE, respectively, in serum as model synovial fluid, with or without fluidic lubricants. For in-vitro cytotoxicity tests, cell morphology and MTT tests were performed by employing murine fibroblast (L929 fibroblasts) and murine osteoblast (MC3T3). Frictional tests showed that the fluidic lubricants display an immediate reduction in the coefficient friction upon injection into serum in which the sliding contacts between CoCrMo pin and UHMWPE disk are taking place. Wear tests of UHMWPE cup after 1 million cycles in hip joint wear simulator showed that gravimetric wear of UHMWPE in serum with F127 was reduced to the level of ca. 20% that in serum alone. Lastly, MTT tests showed that in-vitro cell viability of fibroblast and osteoblast exposed to F127 was comparable to a control when they were exposed to HEPES and cell culture medium only. The experimental results in this study collectively support that the proposed approach in this study, i.e. administration of fluidic lubricants for prosthetic joints, has a high potential to be effective in reducing friction and wear, and thus ultimately improving the longevity of the joint replacement implants.

Biography

Dr. Lee completed his BSc and MSc at Seoul National Univ., and Ph.D. at Univ. of Houston researching on surface chemistry and nanotribology. He then moved to the ETHZ (Switzerland) to work in the field of biomaterials and biomimetic lubrication. Since 2009, he took the position in DTU, and has lead a research group on tribology of biopolymers, implants, and biosurface engineering. He received his ERC Starting Grant in 2010 (LS9 Applied Life Sciences & Biotech) and completed the project in 2015.