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The development and future of ultrahigh molecular weight polyethylene as a synthetic joint bearing surface

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Ultrahigh molecular weight polyethylene (UHMWPE) is part of a bearing couple for over 1 million annual total hip and knee joint replacements in the US. Our work focuses on improving the material properties to address problems that cause revision surgeries such as osteolysis and joint dislocation and to improve the function and feasibility of the operation for all ages.

Peri-prosthetic osteolysis induced by wear, the leading problem causing revision, appears reduced by 'first generation' radiation cross-linked and melted UHMWPE at 10 years of in vivo use. But, the fatigue strength of UHMWPE is decreased by irradiation and melting, which may hinder its use in high stress applications. In addition, a small amount of oxidation was observed recently in long term implants, possibly caused by the absorption of peri-prosthetic lipids into the polymer.

The introduction of the antioxidant vitamin E by diffusion after cross-linking to prevent oxidation was successful in improving the fatigue strength by eliminating melting. The extensive in vitro tests and early clinical outcome using this material has prompted alternative materials using antioxidants to be developed. The wear and oxidation resistance and mechanical properties of these 'second generation' cross-linked UHMWPEs are promising for improving the oxidative stability and the longevity of current designs.

A new family of bearing surfaces based on limiting cross-linking to the surface of the implants to improve mechanical strength further may enable the use of more versatile designs and may allow the use of thinner liners in total hip arthroplasty, preventing dislocation and preserving bone.

Biography

Ebru Oral completed her Ph.D in Chemical Engineering at Purdue University and postdoctoral studies in Orthopaedic Surgery at Harvard Medical School. She is currently junior faculty at the same institution, focusing on improving the performance of medical devices using innovations in polymer science. She has published 32 peer-reviewed papers (which have more than 450 citations), 5 reviews, 4 book chapters and more than 60 conference proceedings. She is also an inventor on 9 families of patent applications.

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