Composition of synovial fluid potential culprit behind osteoarthritis

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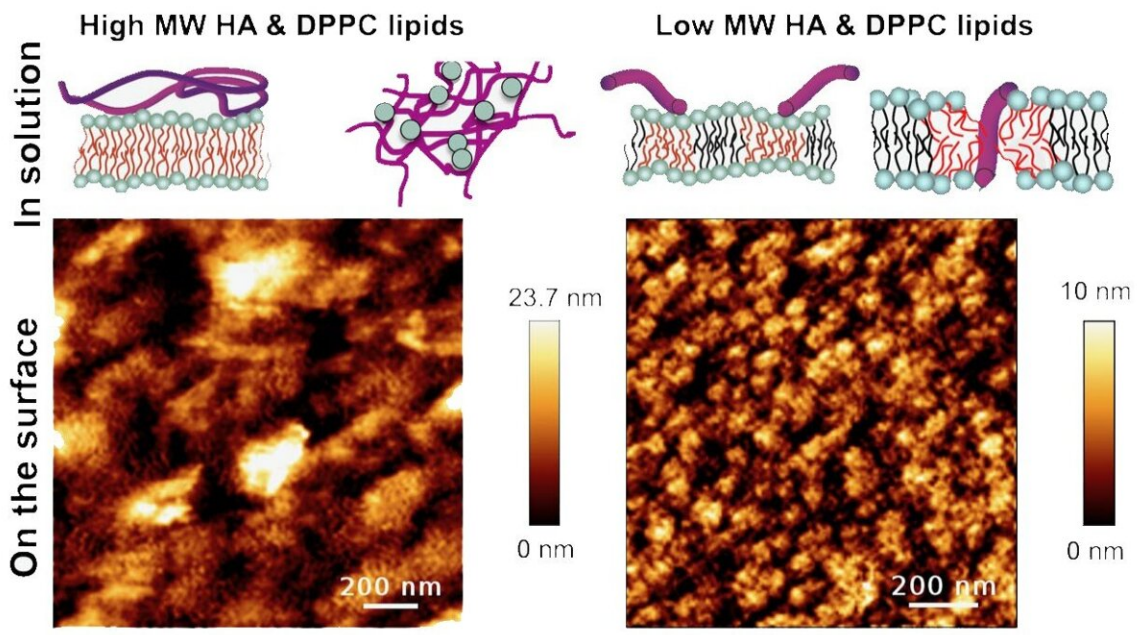

The complex interplay between phospholipid and hyaluronic acid self-assembly in solution, and the molecular weight of hyaluronic acid, determine surface affinity and the formation of a protective film on cartilage. Credit: Kangdi Sun, Tooba Shoaib, Mark W. Rutland, Changwoo Do, and Rosa M. Espinosa-Marzal

Osteoarthritis is a degenerative joint disease caused by the breakdown of cartilage that afflicts more than 35 million adults in the U.S. The exact mechanism of cartilage breakdown in osteoarthritis is unknown, but damage from mechanical stress with insufficient self-repair is believed

to be the main culprit.

The composition of synovial fluid, or joint lubricant, changes significantly in osteoarthritis: The concentration and molecular weight of hyaluronic acid tends to decrease and is commonly used to diagnose the disease.

An international group of researchers has explored the disease-driven breakdown of hyaluronan and the mechanistic implications of these changes on the lubrication and subsequent wear of joints. Their article, "Insight into the assembly of lipid-hyaluronan complexes in osteoarthritic condition," is authored by Kangdi Sun, Tooba Shoaib, Mark W. Rutland, Changwoo Do, and Rosa M. Espinosa-Marzal. It is published in the journal *Biointerphases* on April 11, 2023.

"One of the most important properties of the synovial fluid is its viscosity," said co-author Rosa Maria Espinosa-Marzal of the University of Illinois Urbana-Champaign. "Viscosity is a measure of the internal frictional force between adjacent layers of a fluid in relative motion, or, more simply, a fluid's resistance to flow. Large, high molecular weight polymers such as hyaluronic acid play a significant role in maintaining a high viscosity of the synovial fluid, which helps maintain a fluid film and reduces friction between articulating surfaces during motion."

Through analysis with neutron and light scattering (studies carried out by Changwoo Do and Tooba Shoaib at Oak Ridge National Laboratory), the team determined that the structure of the lipid-hyaluronic-acid complexes in the bulk solution is a function of concentration and its molecular weight.

Researchers at the University of Illinois Urbana-Champaign, Kangdi Sun and Espinosa-Marzal, in collaboration with Mark Rutland, from KTH Royal Institute of Technology, found the hyaluronic acid's concentration

and molecular weight both play a role in how the lubricant reacts with different surfaces.

"Our results show low molecular weight hyaluronic acid, which mimics osteoarthritis-diseased joints, hinders the adsorption of the hyaluronic-acid-lipid complex," said Espinosa-Marzal. "The lack of the formation of an amorphous film on the surface may reflect a consequence of osteoarthritis, since this film should help reduce friction and wear."

Their hypothesis is that this film's absence may increase wear of the cartilage surface. In contrast, high molecular weight hyaluronic-acid-lipid complexes form an amorphous film, which presumably helps maintain the mechanical integrity and longevity of efficient lubrication in healthy cartilage.

Studies on hyaluronic acid itself and hyaluronic-acid-lipid complexes "do not entirely support hyaluronic acid's role in providing high lubricity to the cartilage's articular surface, which is still a bit controversial," Espinosa-Marzal said. "Our results indicate that for low molecular weight hyaluronic acid, this is likely the case."

By exploring the complex interplay between phospholipid and hyaluronic acid self-assembly, and the role of molecular weight on surface affinity, "our study illuminates a mechanism whereby the 'vicious circle' of osteoarthritis can be explained," said Rutland.

More information: Insight into the assembly of lipid-hyaluronan complexes in osteoarthritic condition, *Biointerphases* (2023). DOI: 10.1116/6.0002502

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