Interaction with Cartilage Increases the Viscosity of Hyaluronic Acid Solutions

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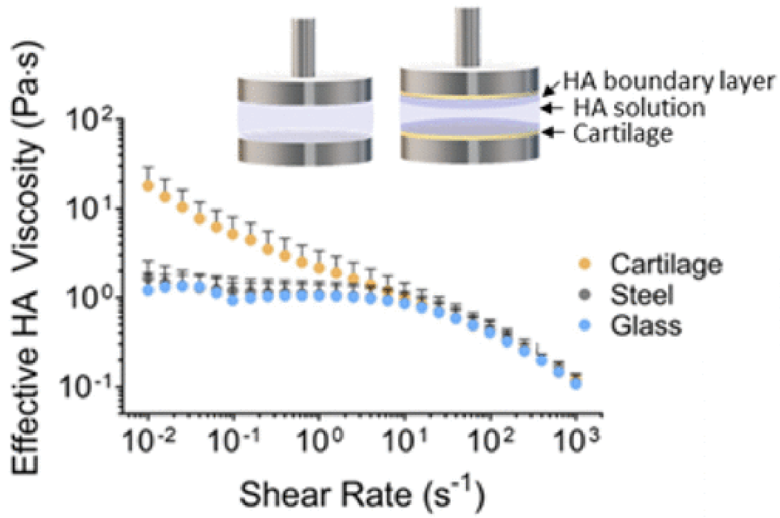
Abstract



Injection of hyaluronic acid (HA) viscosupplements is a prevalent treatment for patients suffering from mild to moderate osteoarthritis. The efficacy of these supplements is attributed to increased synovial fluid viscosity, which leads to improved lubrication and reduced pain. Therefore, viscosity is a key parameter to consider in the development of HA supplements. HA localizes near the cartilage surface, resulting in a viscosity gradient with heightened viscosity near the surface. Traditional rheological measurements confine HA between metal fixtures and therefore do not capture the effect of HA localization that occurs on cartilage. In these experiments, we investigate the effect of modifying rheometer fixtures with cartilage surface coatings on the effective viscosity of HA solutions. Our results demonstrate up to a 20-fold increase in effective viscosity when HA was confined between cartilage surfaces compared to steel surfaces. For low-molecular-weight HA, the effective viscosity was dependent on the gap height between the rheometer plates, which is consistent with the formation of a viscous boundary film. Together, these results indicate that this method for assessing HA viscosity may be more relevant to lubrication than traditional methods and may provide a more accurate method for predicting the viscosity of HA viscosupplements in vivo where HA is able to interact with the cartilage surface.

Supporting Information

The Supporting Information is available free of charge at https://pubs.acs.org/doi/10.1021/acsbiomaterials.0c00100.

- Table S1: Summary of all pairwise comparisons of HA viscosity confined between steel and cartilage surfaces with $p < 0.05$; Table S2: Summary of all pairwise comparisons between gap heights for HA confined between cartilage surfaces with $p < 0.05$; Table S3: Summary of all pairwise comparisons between gap heights for HA confined between steel surfaces with $p < 0.05$; Figure S1: Regression analysis of the effect of gap height on measured HA viscosity (PDF)

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This supporting information is 5 pages and include

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1. Karan Vishwanath, Lawrence J. Bonassar. Intra-articular Hyaluronic Acid Injections. **2022**,, 109-122. https://doi.org/10.1007/978-3-030-84744-9_8

2. Margot S. Farnham, Kyla F. Ortved, Jeffrey S. Horner, Norman J. Wagner, David L. Burris, Christopher Price. Lubricant Effects on Articular Cartilage Sliding Biomechanics Under Physiological Fluid Load Support. *Tribology Letters* **2021**, *69* (2) https://doi.org/10.1007/s11249-021-01430-0

3. Elizabeth Feeney, Devis Galesso, Cynthia Secchieri, Francesca Oliviero, Roberta Ramonda, Lawrence J. Bonassar. Inflammatory and Noninflammatory Synovial Fluids Exhibit New and Distinct Tribological Endotypes. *Journal of Biomechanical Engineering* **2020**, *142* (11) https://doi.org/10.1115/1.4047628