Development of Biomimetic Biopolymers for Healing Early Osteoarthritis

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Insufficient lubrication of cartilage, a protective layer of joints, is one of the leading causes of osteoarthritis (OA). Thus, improving cartilage lubrication is a promising approach to healing OA at the early stage. Healthy cartilage is lubricated by cartilage-binding biopolymers with a brush-like appearance. They are made of hyaluronan (HA) as the main chain and aggrecan and phospholipid as two major side chains. Using trypsin-treated cartilage as an OA-diseased tissue model, I tested the hypothesis that synthetic biomimetic biopolymers could bind and lubricate OA-diseased cartilage with a low friction coefficient. To emulate natural cartilage lubrication, I developed two biopolymers by chemically linking aggrecan-like and phospholipid-like polymers with HA. The biopolymers mimicked the chemical composition and brush-like structure of the natural lubricants. Then their biocompatibility, cartilage binding, and lubrication were evaluated. The two biopolymers were found to bind cartilage with much higher affinity and show significantly better in vitro cartilage lubrication than HA, a clinically used lubricant. Collectively, they lubricated OA-diseased cartilage with an ultralow friction coefficient comparable to that of the natural lubricants. Also, the synthetic lubricants didn't significantly reduce the viability of cartilage-forming cells under proper concentrations, nor did they inhibit in vitro cartilage formation. These results verified their biocompatibility. This work demonstrated that learning the structure and composition of natural cartilage lubricants led to the development of biomimetic biopolymers that could lubricate cartilage. The biomimetic biopolymers hold promise as injectable and biocompatible cartilage lubricants for healing early OA.