FRICTION REDUCING PROPERTIES OF LUBRICIN (PRG4): A NANOSCALE STUDY OF CHONDROPROTECTION

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INTRODUCTION: Lubricin (PRG4) is a classical mucinous glycoprotein [1] providing boundary lubrication of apposed synthetic and cartilaginous surfaces in the absence of viscosity. Cartilage bearings lubricated by synovial fluid possess a very low coefficient of friction $\mu \sim 0.001$ [2] which is attributable to lubricin [3] and interstitial fluid pressurization [4]. Lubricin works in concert with hyaluronate where it regulates the mesh size of the polymer network and also synergistically lowers μ. Although the tribological properties of deposited synovial fluid and lubricin films have been studied on the macroscale, the details of the boundary lubrication mechanism are poorly understood.

METHODS: Friction measurements were conducted by lateral force microscopy between ω-substituted alkane thiol modified surfaces in the presence of physisorbed lubricin.[5] Specificallly, friction was measured between colloidal probes (Figure 1) and surfaces functionalized with self assembled monolayers (SAMs) of hydroxyl or methyl terminated thiols. The objective here was to study the effect of lubricin on friction in absence of fluid pressurization on model surfaces that recapitulate the salient chemical features of the superficial surface of cartilage.

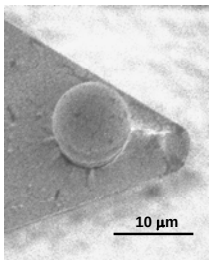

Fig 1: *Colloidal probe (10µm) attached to AFM cantilever.*

RESULTS: Surface plasmon resonance studies showed that on the OH-terminated thiol surface a monolayer formed at a lubricin concentration of ~200 µg/ml. Lubricin is amphiphilic, adsorbing to both polar and nonpolar surfaces, and provides significant steric repulsion, even at a low concentration. The μ is low (~0.045) for non-reduced lubricin concentrations <200 µg/ml and larger (~0.10) for concentrations >200 µg/ml (measured between OH-terminated thiol surfaces) (Figure 2). The addition of hyaluronate to lubricin lowered μ (~0.020) compared to lubricin alone on the methyl-terminated thiol surface.

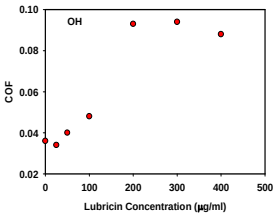

Fig 2: *COF between hydroxyl-terminated surfaces as a function of lubricin concentration.*

DISCUSSION & CONCLUSIONS: These values of μ are much higher than ~0.001 which occurs between cartilage surfaces *in vivo*. In the functioning diarthroidal joint, the large majority of the load is carried by interstitial fluid pressurization. This implies that friction at contacting asperities is low, and that there is not necessarily a need to lower friction. The role of "boundary lubricants" may thus be one to protect cartilage asperities by strong steric repulsion, in absence of interstitial fluid pressurization.

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ACKNOWLEDGEMENTS: NIH AR050180 (G.D.J), NSF DMR-0239769 CAREER (S.Z.)