Structure and rheological meaning of hyaluronic acid in human synovial fluid.

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Synovial fluids typically show high viscosity and high elasticity - qualities, which are necessary for an efficient lubrication of the sliding parts of the joints. The rheological properties of synovial fluid are mainly attributable to the hyaluronic acid (HA) which occurs at a concentration of 2- 3 mg/ml, or its complex with protein. For synovial fluid from patients suffering from rheumatoid deseases, we found a dramatic decreas of the viscosity and of the elasticity; this could possibly be the consequence of a structural change of the HA or its protein complex.

Rheological parameter of synovial fluids.

Diagnosis	η_o [P]	$\eta_o / \eta_{D=300}$	θ [s^{-1}]
normal synovia p.m.	60-120	100	40-100
rheumatoid athritis	1- 40	5-40	10- 20
osteoarthroses	0,05-0,5	1,1-4	0,02-1

η_o = viscosity for zero shear rate
$\eta_{D=300}$ = viscosity for shear rate $300s^{-1}$
θ = proportional to terminal relaxation time (1)

Light scattering measurements on HA from the human umbilical cord yield a molecular weight (MW) of $2.1o^6$ and a radius of gyration (R) of 82 nm. The HA showed a strong tendency to aggregate. A non monotonous fine structure of the scattering curve is fully developed within three weeks, leading to gel-like super molecular particles with MW= $8.5.1o^6$ and R= 110 nm. The scattering function of the aggregates can only be discussed in terms of the Rayleigh- Gans theory.

HA from human synovial fluid was obtained from the knee joints of patients with an inflammatory rheumatoide desease. It was purified by anion exchange chromatography and subsequently fractionated on a sepharose 2B CL column into 3 samples of different molecular weight.

The MW and R of these samples were obtained from wide-angel light-scattering measurements. Their scattering curves showed a fine structure similar to the one of HA from the human umbilical cord. In the Gunier plot two distinct linear regions are observed, leading to two different molecular weights and two radii of gyration. The smaller particles may correspond to monomers, the larger ones to supermolecular aggregates. Values between $0.5.1o^6$ and $4.1o^6$ dalton are observed for the molecular weight and between 42 nm and 82 nm for the radius of gyration.

1. Ferry,J.D., Viscoelastic Properties of Polymers (New York 1970).