The Physiologoy and Pathology of Hyaluronic Acid in Joints
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The role of hyaluronic acid in joints is not fully understood; however, it is generally accepted that it protects the cartilage and soft tissue surfaces from trauma during joint function. The viscoelastic nature of synovial fluid, which bathes all joint tissues, appears to be the key to its protective function and is due to its hyaluronic acid content. The concentration of hyaluronic acid varies with the species studied, the specific joints studied, the age of the individual and the presence or absence of pathologic conditions. (See for review 1)

The viscoelastic properties of synovial fluid depends upon the size, conformation, and concentration of its hyaluronic acid molecules. The dynamic elastic modulus of synovial fluid in young individuals is higher than that found in the synovial fluid of older joints which in turn is greater than that found in the fluids of osteoarthritic joints. However, in all cases, there is an increase in the dynamic elastic modulus as the strain frequency increases. In normal young and older joints the dynamic viscus modulus decreases as the strain frequency increases during vigorous activity. Thus in normal joints, synovial fluid is predominently viscus at low strain frequency and predominently elastic at high strain frequency. In osteoarthritic joints it behaves predominently as a viscus fluid. Since synovial fluid exists between all joints tissue surfaces, it acts as a viscus fluid when joint movement occurs at low shear frequency and at high shear frequencies acts as an elastic solid i.e., absorbing mechanical shock and deformation. In pathologic conditions in human and equine joints, including inflammation, trauma and osteoarthritis there is a decrease in the viscoelastic properties of synovial fluid due to a decrease in the concentration, intrinsic viscosity and molecular weight of hyaluronic acid and thus a decrease in protective function. (2,3,4)

The surface of articular cartilage is covered by a hyaluronic acid-protein complex several micra thick and of higher concentration than that found in the synovial fluid. This layer, adsorbed to the collagen fibrils of the tangential zone of articular cartilage, the superficial collagen fibers of the menisci and at the synovial membrane surfaces, provides further surface protection. This layer is altered significantly during aging. (5) Increased amounts of hyaluronic acid are also apparent in the superficial 100 micra of articular cartilage occupying the spaces between collagen fibrils and is thought to play a significant role in joint lubrication. In the deeper zones of articular cartilage, hyaluronic acid appears to form the major backbone to which core protein and its attached chondroitin sulfates and keratin sulfates sulfates are attached. Hyaluronic acid exerts a number of specific effects on cells which may play a role in patholic conditions. These effects include its actions as a cell immobilizing agent, inhibition of cellular dedifferentiation and mitosis in response to noxious stimuli and the inhibition of granulation tissue and adhesion formation. All of these functions are inhibited by decreases in the concentration and molecular size of the hyaluronic acid molecule such as occurs in pathologic conditions.

The introduction of intra-articular hyaluronic acid has been shown to exert a protective function on traumatized joints. Intra-articular injection of sodium hyaluronate in immobilized rabbit knee joints reduced the frequency of degenerative changes by 50%. Recently intra-articular injections of a highly purified form of sodium hyaluronate have been shown to reduce the symptoms associated with arthritis in both equine and human studies. Post-traumatic arthritis of the fetlock and carpal joints is frequently seen in race horses. Of 116 joints treated by intra-articular injections of sodium hyaluronate, 84% were improved and 71% of horses were able to return to training and racing with no relapse. Intra-articular injection of sodium hyaluronate into osteoarthritic human knees provided objective and subjective improvement lasting at least 3 months in 87% of knees. Side effects in both the human and equine trials were minimal. Post injection studies of synovial fluids revealed a fluid of normal viscosity. (6,7,8,9)

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