

TWO-DIMENSIONAL WATER DIFFUSION IN HYALURONIC DERMAL FILLERS REVEALED BY NMR RELAXOMETRY

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Nuclear Magnetic Resonance (NMR) Relaxometry is one of the unique methods of supplying information about molecular dynamics and structure. According to this method, by a single experiment, one can detect motional processes in a broad range of time scales (from ms to ps). It is possible due to the fact that the relaxation rate is linked with the molecular dynamics. It depends on how fast the proton transitions between its energy levels occur. Those transitions are thanks to magnetic dipole-dipole interactions between magnetic moments of protons, which fluctuate in time due to molecular dynamics, like rotational or translational motion. The spin-lattice relaxation rate, is given as a linear combination of spectral density functions. Determination of the mechanism of the motion could be performed thanks to different mathematical form of those functions. The shape of a relaxation dispersion profile (spin-lattice relaxation rate versus the resonance frequency) is thus a fingerprint of the mechanism of the molecular motion.

In liquid systems, translation diffusion is a very important mechanism of molecular motion which can not be neglected. In most cases, it is concerned as three – dimensional (3D) process. However, when some kind of confinement is present in the system, 1D or 2D diffusion could be considered. The hyaluronic compounds used as dermal filler are an example of systems with 2D translation diffusion. They are one of the main components of the extracellular matrix and a major component of skin, where they are involved in tissue repair and regeneration. The hyaluronic acid is formed of monomers of D-glucuronic acid and N-acetyl-D-glucosamine linked by β -glycosidic bonds. At physiological pH, it occurs primarily in the form of sodium salt and has the ability to bind water. For medical purposes, the hyaluronic acid is cross-link in order to obtain gels with varying degrees of fluidity and rigidity. The water-binding capacity and the characteristics of the processes of gel volume changing after its implantation into tissues are one of the most important factors determining the medical usefulness of dermal fillers. Moreover, the time-scale and mechanism of water dynamics in the hyaluronic acid gels are of high importance. For the purposes of revealing the dynamical properties of water confined in the gel matrices, NMR relaxometry is an excellent technique.

The main purpose of this work is to reveal the mechanisms of water mobility in dermal filler with the purpose of their tailoring towards better efficiency. Moreover, in order to determine possible differences in water dynamics in healthy and pathological tissues, demonstration of the ability of NMR relaxometry to unambiguously identify the mechanism of water diffusion is needed.

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