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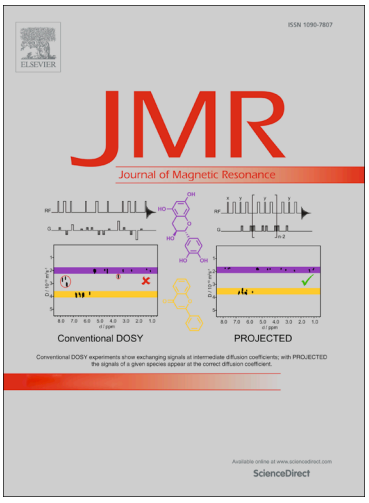

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Sarah E. Mailhiot, Fangrong Zong, James E. Maneval, Ronald K. June, Petrik Galvosas, Joseph D. Seymour

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Quantifying NMR Relaxation Correlation and Exchange in Articular Cartilage with Time Domain Analysis

Sarah E. Mailhiot[1], Fangrong Zong[2], James E. Maneval[3], Ronald K. June[1],

Petrik Galvosas[2], Joseph D. Seymour[4]*

[1]Department of Mechanical Engineering, Montana State University, Bozeman, Montana, USA, 59715

[2]School of Chemical and Physical Sciences, Victoria University of Wellington, Wellington, NZ, 6140

[3]Chemical Engineering, Bucknell University, Lewisburg, Pennsylvania, USA, 17837

[4]Department of Chemical and Biological Engineering, Montana State University, Bozeman, Montana, USA, 59715

*Corresponding Author: J.D. Seymour jseymour@montana.edu

Abstract

Measured nuclear magnetic resonance (NMR) transverse relaxation data in articular cartilage has been shown to be multi-exponential and correlated to the health of the tissue. The observed relaxation rates are dependent on experimental parameters such as solvent, data acquisition methods, data analysis methods, and alignment to the magnetic field. In this study, we show that diffusive exchange occurs in porcine articular cartilage and impacts the observed relaxation rates in T_1-T_2 correlation experiments. By using time domain analysis of T_2-T_2 exchange spectroscopy, the diffusive exchange time can be quantified by measurements that use a single mixing time. Measured characteristic times for exchange are commensurate with T_1 in this material and so impacts the observed T_1 behavior. The approach used here allows for reliable quantification of NMR relaxation behavior in cartilage in the presence of diffusive fluid exchange between two environments.

Keywords

Cartilage, relaxation, exchange

Introduction

Cartilage has been widely studied by NMR relaxation methods (1-10). T_2 relaxation has been correlated to the health of the tissue with increases in observed T_2 values occurring when cartilage is damaged (5). Though T_2 weighted magnetic resonance imaging (MRI) has been used to track disease caused degradation of cartilage such as arthritis, the standard for clinical diagnosis of arthritis in the USA is still x-ray imaging and not MRI.

One aspect which limits MRI methods in this regard is the wide variability in reported T_2 relaxation rates across studies (11) and the difficulty in connecting the observation of multiple sites, populations of different rotational and molecular mobility, to disease progression and diagnosis. Relaxation in cartilage has been shown to be composed of multiple relaxation rates