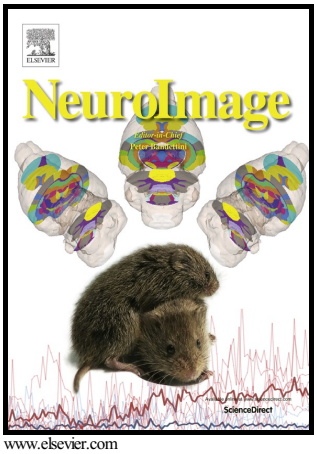
Studying brain microstructure with magnetic susceptibility contrast at high-field

Jeff H. Duyn



www.elsevier.com

PII: S1053-8119(17)30157-X
DOI: http://dx.doi.org/10.1016/j.neuroimage.2017.02.046
Reference: YNIMG13831

To appear in: *NeuroImage*

Received date: 10 November 2016
Revised date: 3 February 2017
Accepted date: 16 February 2017

Cite this article as: Jeff H. Duyn, Studying brain microstructure with magneti susceptibility contrast at high-field, *NeuroImage* http://dx.doi.org/10.1016/j.neuroimage.2017.02.046

Studying brain microstructure with magnetic susceptibility contrast at high-field..

Jeff H. Duyn

Advanced MRI Section, Laboratory of Functional and Molecular Imaging, National Institutes of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, MD 20892, USA

Abstract

A rapidly developing application of high field MRI is the study of brain anatomy and function with contrast based on the magnetic susceptibility of tissues. To study the subtle variations in susceptibility contrast between tissues and with changes in brain activity, dedicated scan techniques such as susceptibility-weighted MRI and blood-oxygen level dependent functional MRI have been developed. Particularly strong susceptibility contrast has been observed with systems that operate at 7 T and above, and their recent widespread use has led to an improved understanding of contributing sources and mechanisms. To interpret magnetic susceptibility contrast, analysis approaches have been developed with the goal of extracting measures that report on local tissue magnetic susceptibility, a physical quantity that, under certain conditions, allows estimation of blood oxygenation, local tissue iron content, and quantification of its changes with disease.

Interestingly, high field studies have also brought to light that not only the makeup of tissues affects MRI susceptibility contrast, but that also a tissue's sub-voxel structure at scales all the way down to the molecular level plays an important role as well. In this review, various ways will be discussed by which sub-voxel structure can affect the MRI signal in general, and magnetic susceptibility in particular, sometimes in a complex fashion. In the light of this complexity, it appears likely that accurate, brain-wide quantification of iron will require the combination of multiple contrasts that may include diffusion and magnetization transfer information with susceptibility-weighted contrast. On the other hand, this complexity also offers opportunities to use magnetic susceptibility contrast to inform about specific microstructural aspects of brain tissue. Details and several examples will be presented in this review.

Keywords: brain, magnetic susceptibility, MRI, microstructure, anatomy, myelin, iron

1. Introduction

One of the greatest strengths of MRI is its flexibility to generate a great variety of contrast. Depending on the type of application (i.e. the type of experiment or "pulse