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Magnetic Resonance Imaging Insights into Ophthalmology

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Statement of the Problem: Blindness and visual impairment related problems have become a major socioeconomic issue during the last decades. Most of them can be avoided, prevented or treated through appropriate programs. Such programs could potentially focus on the implementation of MRI techniques in Ophthalmology due to lower energy deposition in the tissue imaged, no requirement for a transparent light path through the eye during image acquisition, and deep tissue penetration. MRI offers both qualitative and quantitative information in a slice-by-slice manner in scanning times of only a few minutes. Visualization of both superficial and internal ocular anatomical pathophysiology with a wide ranging coverage of physicochemical eye properties can be achieved using MRI. The purpose of this study is to develop a human eye MRI chart for future automated medical diagnosis and MRI implementation in Ophthalmology.

Methodology & Theoretical Orientation: 15 healthy subjects volunteered to undergo MRI of both eyes. 3T MRI was performed using a circular surface coil detector with a 15 minute acquisition protocol. The reference MRI parameters: relaxation times (T1 and T2) and retina/choroid complex layer thicknesses were calculated in the eye regions visualized.

Findings: Visualization of the main eye structures, including three layers in the retina/choroid complex region of the normal human eye was achieved. An MRI chart of the normal human eye was developed using the reference parameters calculated on the post-processed images. A scale for future automated medical diagnosis in Ophthalmology is also proposed based on the reference MRI parameters calculated.

Conclusion & Significance: Multiparametric MRI can be used to, non-invasively, diagnose, stage, and evaluate ocular pathology. Feasibility of MRI implementation in Ophthalmology is demonstrated in this study. Hardware and software developments of anatomically-shaped scanners will make the implementation of the MRI techniques in Ophthalmology more affordable, but also medical staff and patient friendlier.

Recent publications:

1. Curcio CA, Messinger JD, Sloan KR, et al (2011) Human Chorioretinal Layer Thicknesses Measured in Macula-wide, High Resolution Histologic Sections. Invest Ophthalmol Vis Sci 52:3943-3954.
2. Fanea L, Fagan AJ (2012) Magnetic Resonance Imaging in Ophthamology. Mol Vis 18:2538-2560.
3. Fanea L, Nicoara S, Bodea SV, et al (2014) Human Eye Magnetic Resonance Imaging Relaxometry in Diabetic Retinopathy. Rom Rep Phys 66:1029-1037.
4. Patz S, Bert RJ, Frederick E, et al (2007) T(1) and T(2) Measurements of the Fine Structures of the in Vivo and Enucleated Human Eye. JMRI 26:510-518.
5. Richdale K, Wassenaar P, Teal Bluestein K, et al (2009) 7 Tesla MR Imaging of the Human Eye in Vivo. JMRI 30:924-932.
6. Zhang Y, San Emeterio Nateras O, Peng Q, et al (2011) Lamina-Specific Anatomic Magnetic Resonance Imaging of the Human Retina. Invest Ophthalmol Vis Sci 52:7232-7237.

Biography

Laura Fanea's expertise is in magnetic resonance imaging (MRI) of the central nervous system. During the last 16 years, Laura created new pathways for improving medical imaging. Her research in ocular MRI includes the quantitative evaluation of experimental autoimmune uveitis and visualization of the main rat eye structures, but also of the macrophages infiltrated in the diseased retina. She continued her studies with clinical ocular MRI at 1 T, introducing the concept of automated ocular medical imaging through multiparameters calculated on images acquired from normal and diabetic human eyes. Recently, Laura introduced a complex quantitative scale for automated ocular imaging using multiparametric MRI at 3 T and acquiring high quality images of the normal human eyes showing three layers in the region of the retina/choroid complex. Her future plans focus on the development of a reference multiparametric chart of the human eye for automated medical diagnosis in Ophthalmology using MRI.

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