MOLECULAR MEDICINE IRELAND COURSES & WORKSHOP

MMI/CAMI Workshop - Magnetic Resonance Imaging Applications in Research

Date(s): 17 September 2009 (Half-day duration)

Venue:
Institute of Molecular Medicine
Trinity Centre for Health Sciences, St James's Hospital, James's Street, Dublin 8

The purpose of this workshop is to describe the potential of Magnetic Resonance Imaging (MRI) as a research tool in basic and clinical research. MRI allows high resolution imaging of structures and functions in the body without the use of ionising radiation. The high acceptability and low risk of MRI make it very suitable for imaging patient and volunteer cohorts in research studies. Applications include tumour imaging, investigation of cardiovascular function and imaging of neural activity. MRI techniques can follow a concept from an animal model right through to human clinical applications.

Programme

0930 Welcome & Introduction to CAMI
Dr. Jim Meaney (St. James's Hospital)

0940 Overview of MRI Principles & Technology
Dr. Gerard Boyle (St. James's Hospital)

1000 Keynote: MRI as a Research Tool, Developments & Directions
Dr Martin Graves (University of Cambridge)

1100 *Tea/Coffee*

1120 Principles & practice of Animal imaging in MRI
Dr. Andrew Fagan (St. James's Hospital)

1140 MRI research tools in human disease
Dr. Jim Meaney (St. James's Hospital)

1200 Magnetic nanoparticles as contrast agent development in MRI
Prof Yurii Gun'ko (TCD)

1220 Imaging the heart
Dr. Caroline Daly (St. James's Hospital)

1240 Functional imaging of the Brain
Prof. Thomas Frodl (TCD)

1300 Accessing research imaging & planning your MRI project
Dr. Andrew Fagan (St. James's Hospital)

1315 End of workshop

Abstracts

Overview of MRI Principles & Technology
Dr. Gerard Boyle (St. James's Hospital)

Abstract
This presentation is intended as an introductory overview of the principles of MRI imaging and the elements of an MRI system. The presentation is suitable
for those with no prior knowledge of MRI or those seeking a refresher on the
basic principles. How the MRI system generates images through the application of Radio Frequency pulses in a strong magnetic field will be described. The MRI system components used in clinical imaging will be introduced, in particular the RF coils used in different applications. The unique contrast mechanisms used in MRI will be explained. These mechanisms allow excellent soft tissue contrast and in some instances, allow imaging of physiological activity. Limitations and trade offs to be kept in mind when developing an MRI imaging protocol will be introduced.

MRI as a Research Tool, Developments & Directions
Martin Graves (University of Cambridge)

Abstract
MRI scanners can produce images with a wide range of signal differences that allow tissues to be discriminated depending upon their physical and biochemical properties. Images can be obtained with high spatial or temporal resolution to investigate both organ morphology and function. MRI scanners can be programmed to display a wide range of physiological phenomena including: cardiac function, blood flow, diffusion, perfusion and neuronal activation. Although MRI has some contraindications, the absence of ionising radiation means that MRI can be used to study both healthy volunteers and allows serial imaging in patients. Through the use of novel contrast agents MRI is beginning to target cellular and molecular processes. Continuing technical development is establishing MRI as the 'gold-standard' for many clinical and research studies.
References
1. Zahra MA, Tan LT, Priest AN, Graves MJ, Arends M, Crawford RA, Brenton JD, Lomas DJ, Sala E. Semiquantitative and quantitative dynamic contrast-enhanced magnetic resonance imaging measurements predict radiation response in cervix cancer. Int J Radiat Oncol Biol Phys 2009; 74:766-773.
2. Tang TY, Howarth SP, Miller SR, Graves MJ, Patterson AJ, JM UK-I, Li ZY, Walsh SR, Brown AP, Kirkpatrick PJ, Warburton EA, Hayes PD, Varty K, Boyle JR, Gaunt ME, Zalewski A, Gillard JH. The ATHEROMA (Atorvastatin Therapy: Effects on Reduction of Macrophage Activity) Study. Evaluation using ultrasmall superparamagnetic iron oxide-enhanced magnetic resonance imaging in carotid disease. J Am Coll Cardiol 2009; 53:2039-2050.
3. McRobbie DW et al. MRI from picture to proton. Cambridge: Cambridge University Press, 2007.
Biography
Martin Graves is Consultant Clinical Scientist and Head of the MR Physics and Informatics Group at Cambridge University Hospitals NHS Foundation Trust. He has over twenty years' experience in clinical and research MRI in major UK teaching hospitals and has pioneered work in high resolution imaging of atheroma, magnetic resonance fluoroscopy and abdominal MRI in general. He has over 80 peer-reviewed publications and is co-author of the award winning MRI textbook "MRI: from Picture to Proton" and co-editor of "Carotid Disease: The Role of Imaging in Diagnosis and Management". In 2006 he was a recipient of the International Society of Magnetic Resonance in Medicine (ISMRM) Outstanding Teacher Award and in 2009 was inducted into the GE Healthcare "MR Thought Leader" class. He is very honoured to be giving the MMI/CAMI Keynote Lecture.

Principles & practice of Animal imaging in MRI
Dr. Andrew Fagan (St. James's Hospital)

Abstract
This talk will provide an overview of the principles and practises of performing in vivo MRI scanning of rodents. The talk will begin with a brief description of a dedicated animal MRI system and discuss the practicalities of performing in vivo scanning. An overview will then be provided of the range of MRI studies which can be performed on such a system, including: high resolution anatomical imaging, diffusion and perfusion weighted imaging, sodium imaging, molecular imaging using novel nanoparticle contrast agents.
References
1. ILAR J. 2008;49(1):35-53. "Small Animal Imaging with Magnetic Resonance Microscopy" B. Driehuy
2. Progress in Neurobiology 67 (2002) 393–420 "MR microscopy and high resolution small animal MRI: applications in neuroscience research", H. Benveniste et al
3. NeuroRx_: The Journal of the American Society for Experimental NeuroTherapeutics Vol. 2, 250–264, April 2005, "Magnetic Resonance Imaging, Microscopy, and Spectroscopy of the Central Nervous System in Experimental Animals", I.Pirko et al.

Magnetic nanoparticles as contrast agents in MRI
Prof. Y.K. Gun'ko (TCD)

Abstract
Magnetic materials have an enormous impact to the modern science, technology and every day life. In particularly magnetic nanoparticles have been envisaged for many biomedical applications. For example magnetic particles can be utilised as drug delivery agents which can be localized in the body at a site of interest using an external magnetic field. When exposed to an alternating magnetic field, magnetic nanoparticles can serve as powerful heat sources destroying tumor cells; this allows the use of these nanomaterials in cancer hyperthermia therapy. Magnetic fluids based on aqueous dispersions of small size superparamagnetic nanoparticles have also been utilized as contrast agents for magnetic resonance imaging (MRI).1 Our collaborative research resulted in the development of new contrast agents for magnetic resonance imaging based on one dimensional linear assemblies of magnetic nanoparticles. 2 We have demonstrated the potential use of these materials as contrast agents by measuring their MR response in live rats. 3 The new magnetic fluids have shown good biocompatibility and potential for in vivo MRI diagnostics.
References
1. Y. K. Gun'ko and D. F. Brougham, Magnetic Nanomaterials as MRI Contrast Agents,
Chapter 4, Magnetic Nanomaterials, ed. C. Kumar, WILEY-VCH, 2009.
2. S. J. Byrne, S.A. Corr, Y. K. Gun'ko, J. M. Kelly, D. F. Brougham, S. Ghosh, Chem. Commun. 2004, 22, 2560.
3. S. A. Corr, S. J. Byrne, R. Tekoriute, C. J. Meledandri, D. F. Brougham, M. Lynch, C. Kerskens, L. O'Dwyer and Y.K. Gun'ko, J. Amer. Chem. Soc., 2008, 130, 4214.

Neuroimaging in Psychiatric Diseases
Professor Thomas Frodl (TCD)

Abstract
Technological advances have led to greater use of both structural and functional brain imaging to assist with the diagnosis of dementia for the increasing numbers of people with cognitive decline as they age. In current clinical practice, structural imaging (CT or MRI) is used to identify space-occupying lesions, atrophy, vascular changes and stroke. Functional methods, such as PET scanning of glucose metabolism, could be used to differentiate Alzheimer's disease from frontotemporal dementia, which helps to guide clinicians in symptomatic treatment strategies. The impact of neuroimaging in other psychiatric diseases such as mood disorders and schizophrenia is more in research in order to detect neurobiological underpinnings and find markers for treatment response. New neuroimaging methods that are currently being developed can measure specific

neurotransmitter systems, amyloid plaque and tau tangle concentrations, and neuronal integrity and connectivity and may lead eventually to so-called brain-check scans for determining risk of cognitive decline or risk for other psychiatric diseases.

Reference

Frodl et al. 2008, Acta Psychiatrica Scandinavica

Accessing research imaging & planning your MRI project

Dr. Andrew Fagan (St. James's Hospital)

Abstract

This talk will address the initiation and logistics of carrying out an MRI study at CAMI. The early stages of a study generally involve informal discussions with CAMI staff to tease out an idea, discuss its feasibility given the facilities at CAMI, provide advice with applications for Ethical approval, and generally provide support in the preparation of a project proposal for consideration by the CAMI Scientific Committee. Logistical issues relating to the scanning of research patients within a Hospital environment will also be discussed.