Should quantitative MRI sequences become part of routine imaging for Multiple Sclerosis?

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Background

Disease

• Multiple Sclerosis (MS) is a degenerative, autoimmune disorder of the central nervous system\(^1,2\)
• There are over 100,000 sufferers in the UK\(^1,2\)
• Up to 70% of MS sufferers will develop some form of cognitive disability\(^3,4\)

Current Guidance

• Current NICE clinical guidance was published in 2003\(^5\)
• 2011 review of the guidance concluded that an update was necessary\(^6\)
Background

Current Imaging of MS

- The hallmark of MS on conventional MRI (cMRI) are hyperintense lesions on T2 and T1 gadolinium-enhanced sequences[7]
- Clinical disability correlates poorly with cMRI lesion loads[8]
- Quantitative MRI (qMRI) sequences have shown significant grey matter (GM) and normal-appearing white matter damage (NAWM) not seen on cMRI[3,4,8,9,10]

Images: Multiple sclerosis MR imaging and OCB, http://prep-pg.blogspot.co.uk/
Aim

To explore the role of qMRI for imaging diffuse tissue damage in MS; to consider correlations of these findings with cognitive impairment; and to evaluate the potential of qMRI being applied clinically.

Objectives

To assess the utility and clinical practicability of:

• Magnetisation Transfer Imaging (MTI) measures for quantifying tissue disruption
• Diffusion Tensor Imaging (DTI) analysis of damage to white matter tracts and brain connectivity
• Magnetic Resonance Spectroscopy (MRS) measures of key metabolites for indicating neuronal density
Methodology

Systematic Literature Review

- To identify, review and interpret the current primary literature regarding qMRI for imaging GM and NAWM pathology in MS and so give a comprehensive summary of this topic

Databases searched:

- EBSCOhost, Science Direct and Ovid online

Keywords:

- MS, DTI, MTI or MTR, and MRS

Search limitations:

- Inclusion: Published since 2008; all disease patterns; focus on cognitive impairment
- Exclusion: Imaging of the spinal cord or optic nerves; paediatric MS; studies not published in English or with non-human subjects
Discussion

Magnetisation Transfer Imaging

- The searches returned 5 relevant articles
- Studies looking at GM damage found strong correlations with disease severity (p=0.002 and p<0.001)\(^{[11,12]}\)
- The cognitive scores of patients with relapsing disease correlated with MTR in NAWM (p=0.025 and p<0.001)\(^{[13,14]}\)
- There is a lack of standardisation in acquisition and data analysis

Discussion

Diffusion Tensor Imaging

- The searches returned 4 relevant articles
- All studies found increased MD and/or reduced FA in the brains of MS patients compared to healthy controls\(^{[15,16,17,18]}\)
- All the studies reported widespread diffuse damage in NAWM and some correlation between DTI measures and cognitive impairment\(^{[15,16,17,18]}\)
- Manufacturers are beginning to release applications for DTI acquisition and post-processing tools

Discussion

Magnetic Resonance Spectroscopy

- The searches returned 5 relevant articles
- Global reduced NAA and lower NAA in patients with progressive disease were common findings\cite{19,20}
- MRS measures in NAWM correlate well with neurological test scores (p<0.058 and p≤0.05)\cite{14,20,21}
- MRS is technically demanding with results being difficult to replicate between centres

Discussion

Transition to Clinical

• Obstacles:
  - New technology should be minimally labour intensive and integrate with existing departmental workflow\[^{22}\]
  - Acquisition of high quality images must be balanced with practicable acquisition times\[^{22}\]
  - Development of normative ranges\[^{22}\]

Conclusion

QMRI can have a place in the routine clinical imaging of MS. However, a number of barriers must be overcome. DTI and MTI show the most promise and are closer to being applied clinically than MRS. Large scale, longitudinal studies are now necessary.
References

References


Thank you.