Can Magnetic Resonance Spectroscopy Give an Objective Measurement of the Severity of Brain Injury?

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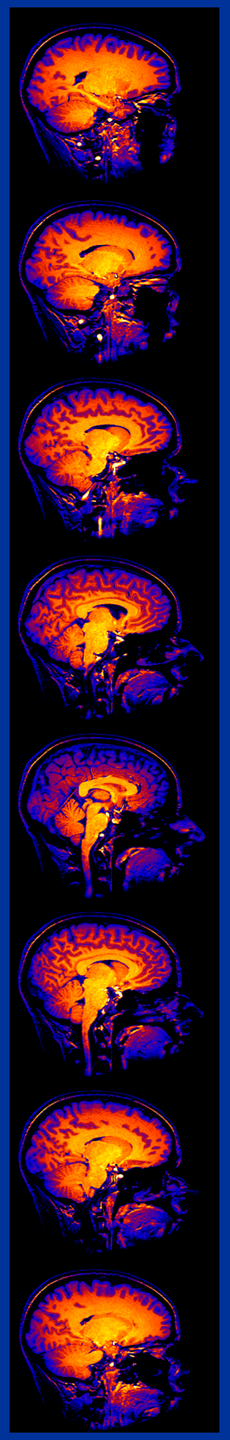

Aims

The aims of this project were:

- To determine if magnetic resonance spectroscopy (MRS) can be used to measure metabolite concentrations in cerebral grey matter.
- To establish whether metabolite concentrations in cerebral grey matter provide an objective measurement of the severity of traumatic brain injury (TBI).
- To determine whether alterations in cerebral grey matter metabolite concentrations explain poor performance on psychological test scores.

Introduction

Blunt TBI results in an estimated 120,000 hospital admissions every year in England with a population demographic which is heavily weighted towards the young [1].

The common prognostic calculators for TBI patients which estimate outcome in terms of mortality and severe disability are not validated in mild and moderately injured patients which form >90% of all cases [2,3]. Importantly, they do not address the cognitive problems commonly experienced following TBI which lead to significantly impaired quality of life, even in the mild injury group.

Magnetic resonance spectroscopy (MRS) is a non-invasive scanning method which offers promise to improve detection of acute diffuse injury and may have a role as a sensitive prognostic marker of long term cognitive dysfunction by detecting changes in concentrations of metabolites [4-6].

This study investigated the sensitivity of MRS to measure grey matter injury and the relationship between acute metabolic changes against performance on cognitive testing.

Methods

Scans were collected from 84 subjects:

53 TBI patients:

- 44 mild (GCS 13 -15, LOC < 30 mins, PTA < 24 hours)
- 9 moderate (GCS 8 -12, LOC < 24 hours, PTA < 7 days)
- Age 34.6 ± 14.6 years (range 17 – 68 years)

31 healthy controls :

- Age 40.9 ± 15.8 years (range 19 – 66 years)
- Matched for years of education

Subjects were studied 6±3.2 days after injury using a 3T MR scanner which allowed a spectrum of brain metabolites to be recorded. A battery of neuropsychological tests was also performed at this time.

Analysis of the MRS data was performed in grey matter structures including the caudate, putamen and thalamus bilaterally and the occipital cortex. These were identified using anatomical MRI scans. The spectrum for each target region was analysed to show peak areas for NAA, Choline and Creatine and the ratios NAA/Cre, Cho/Cre and NAA/Cho were calculated (see Figure 1).

NAA was the primary focus in this study as its concentration positively correlates with neuronal viability i.e. a decrease of NAA corresponds to neuronal injury.

Additional clinical data (GCS, duration of loss of consciousness and duration of post traumatic amnesia) and psychometric data (performance on test of language fluency and category fluency) were also available.

ANOVA analysis was used to identify groupwise differences between control, mild & moderate TBI groups. If a significant difference was found, t-tests were performed. Bivariate regression was used to test for correlations between metabolites levels and clinical or psychometric data.

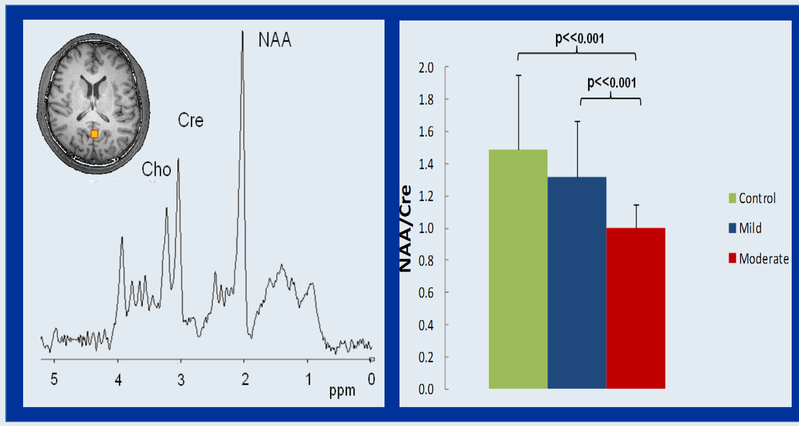

Figure 1:

Left: **Occipital cortex in a moderately injured patient and corresponding spectrum.**

Centre: **Ratio of NAA/Cre in occipital cortex.**

Right: **Regression NAA in occipital cortex to Letter fluency.**

Results

The NAA/Cre ratio in the occipital cortex was found to be significantly different between control, mild and moderate groups (p=0.005, see Figure 1). The differences between control and moderate (t-test, p<<0.001), and mild and moderate (t-test, p<<0.001) were also significant.

The psychometric data showed some significant correlations with metabolites in all groups: NAA and letter fluency (p=0.009, see Figure 1, NAA/Cre and category fluency (p=0.035), and NAA/Cho and letter fluency (p=0.016).

There were further significant correlations with NAA in the injury group alone: NAA and GCS (p=0.003), duration of post traumatic amnesia (p=0.023), letter fluency (p=0.007) and category fluency (p=0.014).

Other deep grey matter showed significant metabolic differences but these were not significant after correction for multiple comparisons.

Conclusions

The results of the study show that:

- The occipital cortex may act as a global indicator of brain injury in the acute stage post TBI.
- NAA/Cre is a useful measure to differentiate severity of TBI and correlated significantly with other clinical measures of severity (post traumatic amnesia).
- Significant regression between NAA and cognitive performance reveals a biological basis for dysfunction in acute mild and moderate head injury .

References

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