Comparison of near infrared spectroscopy with functional MRI for detection of physiological changes in the brain independent of superficial tissue

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Abstract

Background **A reliable portable non-invasive monitor for use in brain injury is needed, so near infrared spectroscopy (NIRS) has potential. Historical inconsistencies in NIRS have prevented its use, often attributed to the contamination of signal from extracranial tissue. We aimed to validate the brain signal from frequency domain NIRS (advanced NIRS technique), comparing its abilities with functional MRI (fMRI) to isolate physiological activity in the brain from those of extracranial tissue.**

Methods **In a prospective healthy volunteer study, nine individuals (six male, three female, age range 21–40 years) performed supine Valsalva manoeuvres (adequacy monitored via finger photoplethysmography and capnography). The Valsalva manoeuvre provided a suitable model for cerebral ischaemia and rises in intracranial pressure. During the manoeuvre, a portable frequency domain NIRS device was targeted separately at the brain and at extracranial tissue, and fMRI (blood oxygen load dependent sequence) was taken from regions corresponding to both fields of NIRS acquisition. Area under the curve analysis of the change in variables during the Valsalva manoeuvre was analysed by the Wilcoxon rank sum method with multiple pairwise comparisons between the brain and extracranial tissue signals for both NIRS and fMRI.**

Findings **We observed similar responses in both brain and extracranial tissue: in all volunteers, oxygenation in brain tissue during the Valsalva manoeuvre decreased (mean –7·2% NIRS [SD 4·7], –3·4% fMRI [SD 1·46]) and oxygenation from the extracranial acquired data increased (mean +6·1% NIRS [SD 2·72], +4·4% fMRI [SD 3·45]), matching physiological predictions. These brain and extracranial signals were significantly different in both fMRI and NIRS (p=0·00025 and 0·00115, respectively).**

Interpretation **Our findings confirm that frequency domain NIRS can detect specific changes within the brain tissue during the Valsalva manoeuvre independent of physiological features of extracranial tissue and reflects changes observed by fMRI. Therefore, the frank changes in the brain observed by frequency domain NIRS are brain specific, demonstrating the potential for this method to be used within the context of brain injury.**

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Contributors
DD designed and implemented the study, and prepared the abstract. SE processed and interpreted the data and prepared the abstract. MC and ZS acquired the data and designed the study. PH was responsible for the MR sequence and data interpretation. HD designed the study and was responsible for NIRS data interpretation and process. AB designed the study and reviewed the data. SL was responsible for physiological modelling and interpretation of physiological data.

Declaration of interests
We declare no competing interests.