Assessment of Cerebrovascular Reserve with Functional MRI

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OBJECTIVE: This study assesses the sensitivity of functional MRI (FMRI) to changes in cerebral blood flow induced by inhalation of carbon dioxide (CO2), as a measure of cerebrovascular reserve.

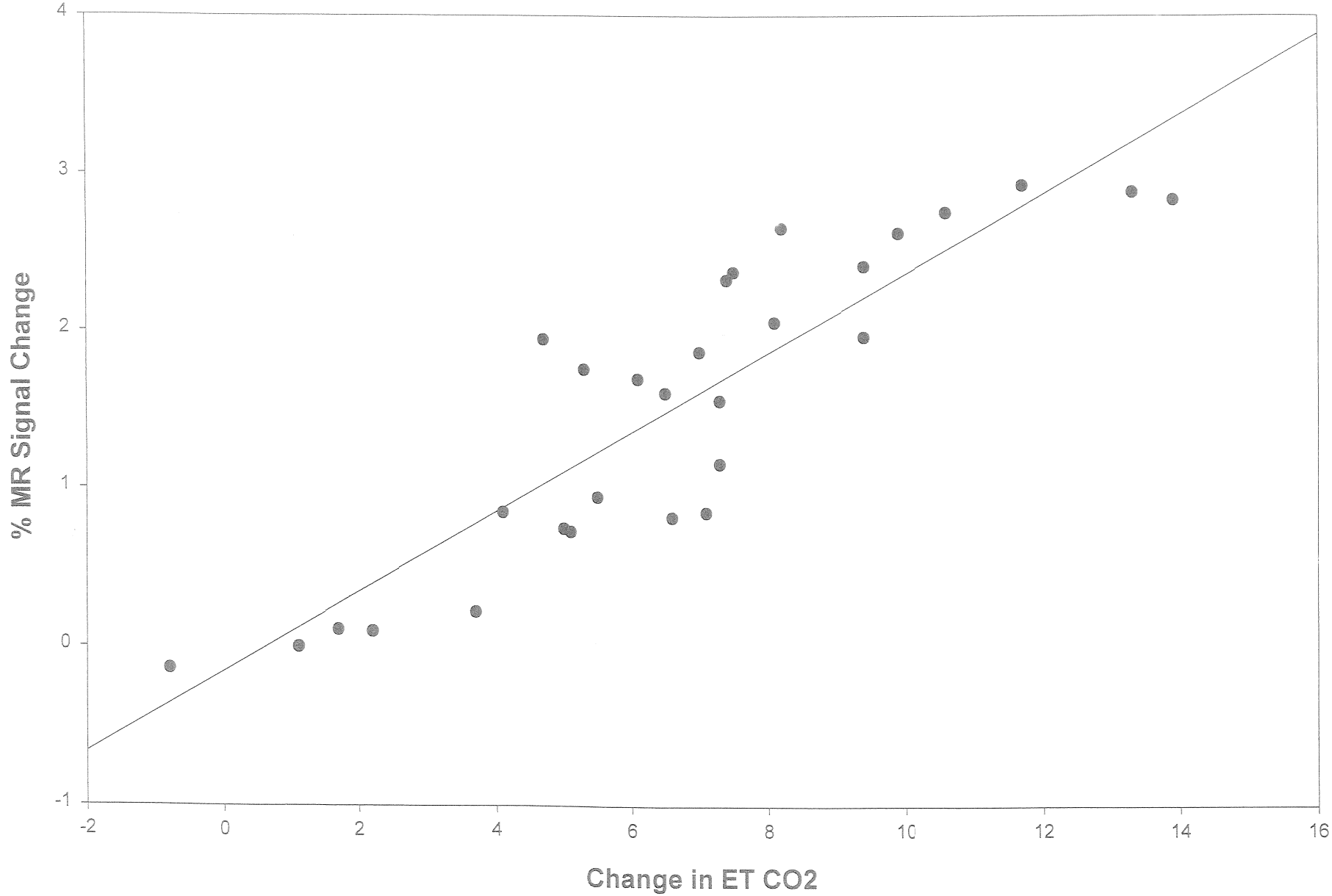
BACKGROUND: Cerebrovascular reserve refers to the capacity for cerebral vasodilation under conditions of increased metabolic demand. Impairment of cerebrovascular reserve may be a predictor of stroke risk in patients with cerebrovascular disease. FMRI is sensitive to increases in venous blood oxygenation, which can be caused by CO2 induced cerebral vasodilation. Use of FMRI to assess cerebrovascular reserve may offer unique functional information with available clinical MRI scanners.

DESIGN/METHODS: Echo-planar MRI of whole brain was performed on a 1.5 T scanner in five healthy subjects during inhalation of 5%, 6%, or 7% CO2 alternating at 2 minute intervals with room air. End-tidal CO2 levels were correlated with MR signal changes. CO2 induced signal changes in gray and white matter (GM,WM) were quantified. Reliability was assessed by test-retest comparisons in the same subjects.

RESULTS: FMRI measurement of CO2 induced vasodilation was reliable in both GM and WM (reliability coefficients GM = .932, WM = .924). MRI signal intensity and end-tidal CO2 levels were highly correlated (correlation coefficients GM = .932, WM = .929). CO2 induced vasodilation was most pronounced in GM and to a lesser extent in WM (mean % signal change from baseline at 5%, 6%, and 7% CO2 in GM = 1.42, 2.14, 2.86 and WM =.57, .79, 1.02).

CONCLUSIONS: FMRI is sensitive to CO2 induced cerebral vasodilation in healthy subjects. The measurements obtained are highly reliable and are strongly correlated with end-tidal CO2 changes. CO2 inhalation with FMRI may offer a useful method of assessing patients at risk for stroke.

Correlation of % MR Signal Change and ET CO2
Gray Matter
Correlation coefficient = .888 (n =29)



% MR Signal Change
compared to room air inhalation