The Age Dependence of qCBF Measure with the Bookend Technique

T. J. Carroll[1], W. Shin[2], H. Jeong[3], M. Walker[3], A. Shaibani[3], M. Rohany[4], J. Carr[4], T. Cashen[4]

[1]Biomedical Engineering, Northwestern University, Chicago, IL, United States, [2]Northwestern, Chicago, IL, United States, [3]Northwestern University, Chicago, IL, United States, [4]Northwestern University, Chicago, iL, United States

Introduction: There is growing interest in the quantification of cerebral blood flow (CBF) using MRI in the scientific community. Both the American Heart and Stroke Association and the ISMRM have targeted qCBF with MRI as a key component for the understanding the pathophysiology of stroke, Alzheimer's disease and vascular proliferation in tumors. Recently an imaging protocol has been developed which has shown promise of the quantification of CBF in humans [1]. Results in animal models of stroke using colored microsphere deposition as a standard of reference support the accuracy of this technique in a setting of acute stroke. It is of interest to the broader clinical community to validate this technique in a clinical setting and to compare the sensitivity to the qCBF to subtle differences in CBF. We have implemented this image protocol on a clinical scanner and collected qCBF images in a series of patients in order to validate qCBF values. We report on the age dependence of qCBF measurement with MRI and compare the observed trends with previously published PET results [2].

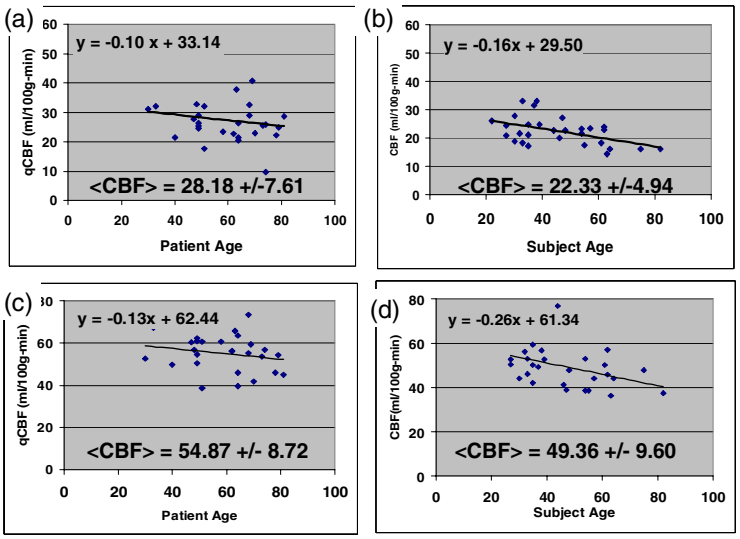

Figure 1: We have measured the age dependence of quantitative Cerebral Blood Flow (qCBF) in a series of 28 patients. We present the age dependence for (a) White Matter (WM) and (c) Gray Matter (GM) separately. (b) and (d) are previously reported H2[O15] PET qCBF values [2]. The trends seen in the MRI based measurements agree with the reference values provided by PET. Furthermore mean values are in agreement when pooled over patient.

Methods: A series of 28 consecutive patients scheduled for follow-up MR perfusion exams to rule out tumor recurrence (male: 9, female: 19, mean age = 51.9 ± 15.9 years) were scanned using the Bookend Technique [1]. This includes: a single slice, multi-phase, inversion recovery TrueFISP sequence [3] to measure T1: single slice (5.0 mm thick, 220 mm x 160 mm FOV, 128 x 104 matrix, BW=1221 Hz/pixel). A nonselective adiabatic hyperbolic secant inversion pulse, which minimizes inflow effects, linear ramp to establish steady-state magnetization with a train of RF pulses with alternating phase (TR = 2.81ms, TE = 1.26 ms, F.A. = 30°). The acquisition is segmented (N_{seg} = 3 phase encodings per segment) leading to a time resolution of N_{seg} x TR (8.43 ms) during recovery from inversion. Total scan time 1:20. This was combined with our standard clinical perfusion scan: Gradient echo single shot EPI sequence: FOV= 220×220 mm, slice thickness = 5 mm, 13 slices, TR/TE = 1500/46 ms, 50 number of measurement, total scanning time = 1:10. Images were post-process to produce qCBF, including a correction for water exchange effects [4].
Regions of interest were placed to cover normal white matter and gray matter using a technique developed to obtain standard reference values in cases of suspected tumors [5]. Gray matter ROIs were placed in the putamen which has been shown to be less susceptible to partial volume average with large blood vessels than cortical gray matter. White and gray matter ROI values were analyzed separately as a function of patient age. A recursion analysis was performed to determine any age dependence, and tabulated results from [2] were recorded and subject to the same analysis.

Results: Mean values of qCBF were 28.2 +/- 7.6 ml/100g-min and 54.9 +/- 8.7 ml/100g-min fro white matter and gray matter respectively, in agreement with PET values (Figure 1). A recursion analysis showed a decline of (3.5+-1.4)%/ decade in white matter and (2.4+/-1.4)% in gray matters which is slightly lower than the (7.1+/-2.0)% and (5.2 +-2 2)%/decade decline observed in the PET data, by in agreement within errors.

Conclusion / Discussion: We have shown the qCBF using MRI is accurate and sensitive to age dependent change in a clinical population. Our age dependence is slightly less that the observed PET trend potentially indicating a patient selection bias. Cardiac output should be considered as a potential bias in future studies.

References:

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5. Cha *et al., AJNR* (2005)