ADNI Alzheimer's Disease Neuroimaging Initiative

MRI Infarct Assessment in ADNI

Charles DeCarli, MD, Owen Carmichael, PhD, Jing He, MD
Department of Neurology and Center for Neuroscience, University of California at Davis

Summary

While Alzheimer's disease (AD) is the most common cause for dementia among older individuals [1,2] and the primary goal of ADNI, the lifetime risk for stroke equals and may exceed the risk of AD in some circumstances [3]. In addition, MRI evidence of asymptomatic cerebrovascular disease (CVD) occurs in one-third of older individuals [4]. In community based studies, mixed pathologies account for the most common cause of dementia [5] and the impact of cerebrovascular and AD pathology is additive, particularly when the AD pathological burden is mild [6]. Similarly, MRI community based studies have shown that white matter hyperintensities (WMH) increase with advancing age and associated vascular risk factors [4,7] and are associated with an array of cognitive deficits in cross-sectional studies [8-10]. Similar cross-sectional differences are also seen with clinically silent brain infarctions noted on MRI [4,11,12]. Importantly, community based studies show that both WMH and SBI are associated with cognitive decline and *incident* MCI and dementia [13,14].

These results strongly suggest that vascular brain injury (WMH, SBI) occurs commonly amongst older community dwelling cognitively normal individuals and is associated with subtle cognitive impairment, including memory impairment. Importantly, increasing survival from vascular disease including hypertension, diabetes, myocardial infarction and stroke is likely to increase the prevalence of asymptomatic vascular brain disease thereby increasing the public health consequences of cognitive impairment related to these disorders. Furthermore, the age of onset of these diseases is quite early and cognitive effects appear to begin similarly early in life, possibly before age 60 [10,14,15]. These findings have led us to postulate that clinically silent vascular brain injury is an important cause of cognitive impairment amongst otherwise healthy individuals, including ADNI participants. Understanding the impact of vascular disease on cognition will not only improve our understanding of the biology of cognitive impairment, but will assist the clinical therapeutic research community in identifying individuals in whom a second cause of cognitive impairment may be present and accounted for in their AD treatment efficacy analysis.

Method

MRI Infarct Detection

The image set of each individual imaging session in ADNI is reviewed by a physician specially trained in the detection of MRI Infarcts. The presence of MRI infarction is determined from the size, location and imaging characteristics of the lesion. Our image analysis system allows simultaneous projection of the complete imaging sequence dataset at three times magnified view to assist in interpretation of lesion characteristics. Signal void, best seen on the T2 weighted image was interpreted to indicate a vessel. Only lesions 3mm or larger qualified for consideration as cerebral infarcts. Other necessary imaging characteristics included: 1) CSF density on T1 and 2) if the infarct was in the basal ganglia area, distinct separation from the circle of Willis vessels. Kappa values for agreement amongst the three raters were generally good and ranged from 0.73 to 0.90 and consistent with previously published reports[4,16]. If an infarct is identified, the location is marked in image space and transferred to the database in image coordinates, enabling follow-up review. When multiple image sets are available spanning repeated imaging sessions, the operator reviews all available images to assure consistency in assessment.
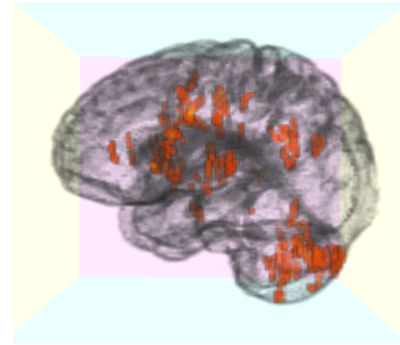
Figure MRI Infarct distribution.

About the Authors

This document was prepared by Charles DeCarli, University of California at Davis. For more information please contact Charles DeCarli at cdecarli@ucdavis.edu or Owen Carmichael ocarmichael@ucdavis.edu.

REFERENCES

1.   Sayetta RB. Rates of senile dementia, Alzheimer's type, in the Baltimore Longitudinal Study. J Chronic Dis 1986;39:271-86.
2.   Evans DA, Funkenstein HH, Albert MS, et al. Prevalence of Alzheimer's disease in a community population of older persons. Higher than previously reported. JAMA 1989;262:2551-6.
3.   Seshadri S, Beiser A, Kelly-Hayes M, et al. The lifetime risk of stroke: estimates from the Framingham Study. Stroke 2006;37:345-50.
4.   Decarli C, Massaro J, Harvey D, et al. Measures of brain morphology and infarction in the framingham heart study: establishing what is normal. Neurobiol Aging 2005;26:491-510.
5.   Schneider JA, Arvanitakis Z, Bang W, Bennett DA. Mixed brain pathologies account for most dementia cases in community-dwelling older persons. Neurology 2007;69:2197-204.
6.   Schneider JA, Wilson RS, Bienias JL, Evans DA, Bennett DA. Cerebral infarctions and the likelihood of dementia from Alzheimer disease pathology. Neurology 2004;62:1148-55.
7.   Jeerakathil T, Wolf PA, Beiser A, et al. Cerebral microbleeds: prevalence and associations with cardiovascular risk factors in the Framingham Study. Stroke 2004;35:1831-5.

8. DeCarli C, Murphy DG, Tranh M, et al. The effect of white matter hyperintensity volume on brain structure, cognitive performance, and cerebral metabolism of glucose in 51 healthy adults. Neurology 1995;45:2077-84.

9. Swan GE, DeCarli C, Miller BL, et al. Association of midlife blood pressure to late-life cognitive decline and brain morphology. Neurology 1998;51:986-93.

10. Au R, Massaro JM, Wolf PA, et al. Association of white matter hyperintensity volume with decreased cognitive functioning: the Framingham Heart Study. Arch Neurol 2006;63:246-50.

11. Das RR, Seshadri S, Beiser AS, et al. Prevalence and correlates of silent cerebral infarcts in the Framingham offspring study. Stroke 2008;39:2929-35.

12. Aggarwal NT, Wilson RS, Bienias JL, et al. The association of magnetic resonance imaging measures with cognitive function in a biracial population sample. Arch Neurol 2010;67:475-82.

13. Debette S, Beiser A, Decarli C, et al. Association of MRI Markers of Vascular Brain Injury With Incident Stroke, Mild Cognitive Impairment, Dementia, and Mortality. The Framingham Offspring Study. Stroke 2010.

14. Debette S, Seshadri S, Beiser A, et al. Midlife vascular risk factor exposure accelerates structural brain aging and cognitive decline. Neurology 2011;77:461-8.

15. Seshadri S, Wolf PA, Beiser A, et al. Stroke risk profile, brain volume, and cognitive function: the Framingham Offspring Study. Neurology 2004;63:1591-9.

16. Hachinski V, Iadecola C, Petersen RC, et al. National Institute of Neurological Disorders and Stroke-Canadian Stroke Network vascular cognitive impairment harmonization standards. Stroke 2006;37:2220-41.

June 9, 2013