Computer Tomography for Prediction of Cognitive Outcomes after Ischemic Cerebrovascular Events

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Background: The aim of this study was to evaluate whether parameters noted on a single, acute computed tomographic (CT) scan, are associated with significant cognitive impairment (SCogI), and can help in the prediction of SCogI 3-6 months after stroke or transient ischemic attack (TIA). *Methods:* Patients with a recent (≤14 days) ischemic stroke or TIA, without preexisting dementia, underwent non-contrast CT scan within 24 hours of admission. A formal neuropsychologic battery was administered 3-6 months from index stroke. SCogI was defined as moderate cognitively impaired, not demented (CIND) (≥3 domains impaired), and dementia diagnosed according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition,* criteria. Logistic regression models were used to examine associations between CT parameters and SCogI. Receiver operating characteristic analysis with an area under the curve (AUC) was performed to assess discriminatory ability of radiological parameters for SCogI. *Results:* In all, 318 patients were included: 250 (78.6 %) with ischemic stroke and 68 (21.4%) with TIA; the mean age was 59.8 (±11.4) years. At 3-6 months, 76 (23.9 %) had SCogI (67 CIND moderate and 9 dementia). The presence of significant atrophy (P = .02) and chronic infarcts (P = .03) were associated with SCogI at 3-6 months. A significant increase in AUC was noted after addition of summarized CT results to a clinical score derived from age and baseline Montreal Cognitive Assessment (cutoff 21 of 22) for detection of SCogI: .83 (.78-.89) to .86 (.82-.91); P = .03. *Conclusions:* CT parameters are independently associated with SCogI at 3-6 months after an ischemic cerebrovascular event and may be a clinically useful component in predicting for SCogI after stroke. **Key Words:** Stroke—transient ischemic attack—cognitive impairment—dementia.

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Introduction

Dementia is a major global public health challenge with an estimated 42.3 million people worldwide who will be living with dementia by 2020.[1] Stroke increases the risk for incident dementia: in individuals older than 65 years, after a stroke, the reported rates of incident dementia at 3-6 months vary from 5.5% to more than 25%.[2] Cognitive impairment (CogI) after a stroke is common and has significant clinical implications.[3] In addition to increasing the risk for dementia, more severe CogI poststroke is also associated with an increased risk of mortality, disability, and recurrent vascular events.[4,5] Significant impairment in activities of daily living is noted even in cognitively impaired, not demented (CIND) patients at 3 months after a stroke.[6]

Identification of predictors for significant CogI after a stroke is important for early institution of appropriate and patient-specific, pharmacologic, and rehabilitative measures, with a view to improve clinical outcomes. Increasing age, presence of silent infarcts, and cerebral atrophy have been variously reported to be associated with poststroke dementia; however, whether these associations hold true for less severe CogI is not known.[2,7-9] It has also been previously shown that the baseline Montreal Cognitive Assessment (MoCA), using a cutoff of 21 of 22, has a good sensitivity (.88) for significant CogI at 3-6 months after stroke or transient ischemic attack (TIA).[10]

The aim of the present study was to evaluate whether parameters noted on the baseline computed tomographic (CT) scan, routinely performed in all patients presenting to the emergency services with an ischemic stroke or TIA, (a) are associated with significant CogI at 3-6 months after the index event and (b) can be useful for the prediction of significant CogI after stroke or TIA.

Methods

Four hundred clinically stable patients with a recent (≤14 days) ischemic stroke or TIA admitted to the stroke neurology service at the National University Health System, Singapore, were recruited between June 2009 and April 2012. The exclusion criteria included (a) major disability (modified Rankin Scale score >4), (b) significant aphasia or dysarthria (the National Institutes of Health Stroke Scale [NIHSS] score, best language [aphasia], and dysarthria score >1) that impeded cognitive assessment, (c) major and active psychiatric illness, (d) pre-existing dementia or a score more than 3.38 on the Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE),[11] and (e) acute delirium (Delirium Rating Scale—Revised).[12]

The study was approved by the Domain-Specific Review Board and Ethics Committee of the National Healthcare Group, Singapore. Written informed consent was obtained from all participants or their legally acceptable representatives.

Baseline Assessments

Information on demographics (age, gender, ethnicity, and years of education) and clinical information (history of hypertension, diabetes, dyslipidemia, ischemic heart disease, previous stroke, or TIA) was collated. Cognitive status was assessed using the MoCA, and IQCODE was administered for all patients. The NIHSS score was used as a marker for stroke severity. Each patient underwent cranial neuroimaging at baseline within 24 hours of presentation to the hospital; a noncontrast CT scan was performed, using a 64-channel Philips Brilliance scanner. All scans were evaluated by a single trained rater, blinded to the clinical and cognitive characteristics. The following parameters were noted and graded:

1. White matter lesions, using the Age-Related White Matter Changes scale: patients were dichotomized into mild and significant white matter disease using a score of 7 or more as cutoff.[13]
2. Atrophy: visual rating of global cortical atrophy as established by Pasquier et al[14]; significant atrophy was defined as a score of 7 or more.
3. Infarcts were categorized into
   (a) acute infarcts—presence of early ischemic signs, including cortical swelling, blurring of the gray–white demarcation, and decrease in signal density, and
   (b) chronic infarcts—hypodensity approaching that of cerebrospinal fluid and lesions with evidence of volume loss.

All infarcts were classified on the basis of location into cortical (involving cortical surface), subcortical (infarct involving the subcortical white matter, including internal and external capsule, caudate, or the lentiform nucleus), thalamic, and infratentorial (cerebellum or brain stem). The laterality (right, left, and bilateral) for all supratentorial infarcts was noted.

Follow-up Assessment at 3-6 Months

Patients were followed up at 3-6 months after the index event for their neurologic status and clinical outcomes, including recurrence of stroke or TIA.

Cognitive Measures

Patients were assessed using a formal neuropsychologic battery locally validated for older Singaporeans, administered by trained research psychologists blinded to the baseline cognitive performance.[15] The domains of the formal neuropsychologic battery included (1) attention (digit span test, visual span test and auditory detection test); (2) language (modified Boston naming and