A Novel Useful Tool of Computerized Touch Panel–Type Screening Test for Evaluating Cognitive Function of Chronic Ischemic Stroke Patients

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Cognitive and affective impairments are important non-motor features of ischemic stroke (IS) related to white-matter hyperintensity, including periventricular hyperintensity (PVH). To confirm the usefulness of a novel computerized touch panel–type screening test, we investigated cognitive and affective functioning among 142 IS patients and 105 age-and gender-matched normal control subjects. Assessment using the mini-mental state examination, Hasegawa Dementia Scale-Revised, and frontal assessment battery revealed reduced cognitive function in IS patients, with the most severe reduction exhibited by cardiogenic embolism patients, followed by lacunar infarction patients, and atherothrombotic infarction patients. Our novel touch panel screening test revealed a similar pattern of results. In addition, PVH grading, classified using Fazekas' magnetic resonance imaging method, was also correlated with cognitive decline and touch panel screening test performance. In contrast, affective function, assessed with the 15-item Geriatric Depression Scale, vitality index, and apathy scale, was not significantly decreased in IS, and did not correlate with touch panel screening test results or PVH, although the number of microbleeds was correlated with apathy scale results. The present findings revealed that IS and PVH grading were significantly correlated with decline in general cognitive status (mini-mental state examination and Hasegawa Dementia Scale-Revised) and frontal lobe function (frontal assessment battery). Performance on all touch panel screening tests was correlated with IS and PVH grading, but was largely independent of depression or apathy. Touch panel screening tests were easily understood and performed by almost all patients with mild cognitive and motor dysfunction, due to visually clear images and simple methods not involving detailed manual-handling tasks such as writing. Touch panel screening tests may provide a useful tool for the early screening of cognitive function. **Key Words:** Touch panel screening test—cognitive and affective function—periventricular hyperintensity—microbleeds.

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Cognitive impairment is one of the most important non-motor features of ischemic stroke (IS). Dementia is reported to occur in 19.3% of stroke cases, a significantly greater rate than in age-and gender-matched controls.[1] Several magnetic resonance imaging (MRI) studies reported that white-matter hyperintensity (WMH), such as periventricular hyperintensity (PVH), is associated with cognitive impairment[2-4] and depression.[5-7] In addition, recent studies reported that microbleeds are also associated with cognitive impairment[8,9] and depression.[10]

The early detection of cognitive and affective decline associated with IS is important, because early detection may help predict long-term outcome and could aid early interventions and rehabilitation treatment strategies. Although several studies have attempted to detect the early stages of cognitive and affective decline,[11,12] more user-friendly screening tests are required to respond to the rapid increase of dementia patients in aging societies such as Japan. Therefore, the current study focused on examining a computerized touch panel–type screening test, testing whether patients with cognitive dysfunction due to IS could understand and perform the tests.

Although several previous studies have reported computerized touch panel–type screening tests,[13-15] none have examined whether the computerized touch panel–type screening test results are correlated with standard cognitive or affective function tests, the severity of PVH, and microbleeds in IS patients. To investigate these questions, we examined cognitive and affective functioning in relation to PVH abnormalities and microbleeds in IS patients.

Methods

Participants

Patients (n = 142) diagnosed with different types of IS, including lacunar infarction (LI) (73.4 ± 8.9 years old at time of examination, 68.0 ± 10.8 years old at onset, clinical dementia rating [CDR] 0.08 ± 0.22, n = 76, 50 male and 26 female), atherothrombotic infarction (AT) (70.9 ± 10.2 years old at time of examination, 66.2 ± 11.7 years old at onset, CDR 0.09 ± 0.24, n = 53, 32 male and 21 female), and cardiogenic embolism (CE) (73.0 ± 7.2 years old at time of examination, 67.0 ± 10.6 years old at onset, CDR 0.41 ± 0.80, n = 13, 8 male and 5 female), who attended the Stroke Outpatient Clinic of the Okayama University Hospital between April 1999 and December 2011 were included in the present study. LI, AT, or CE patients were diagnosed according to the Trial of Org 10172 in Acute Stroke Treatment stroke subtype classification system.[16] For comparison, 105 healthy controls (71.3 ± 10.3 years old at the examination, 60 male and 45 female) matched in terms of age and gender were also included. The criteria for inclusion as controls included the absence of any past or present neurological or psychiatric disorders, and having a normal CDR score (ie, 0).[17]

Clinical information, such as medical history, educational history, the incidence of hemiparesis and ataxia in the dominant hand, homonymous hemianopsia, aphasia, apraxia, hemispatial neglect, hypertension, hyperlipidemia, diabetes mellitus, and smoking status, were collected from both healthy controls and IS groups (Table 1).

Cognitive and Affective Function

Neuropsychiatric batteries including mini-mental state examination (MMSE), Hasegawa Dementia Scale-Revised (HDS-R), frontal assessment battery (FAB), 15-item Geriatric Depression Scale (GDS), vitality index (VI), and the apathy scale (AS) were conducted to evaluate general cognitive and frontal functions, and affective functioning, such as depression, vitality, and apathy. The MMSE evaluates 7 aspects of cognition, such as orientation, registration, attention and calculation, recall, comprehension of spoken language (naming objects, spoken language ability, following commands), writing, and construction drawing, with a maximum performance score of 30.[18] The HDS-R includes questions about the subject's age, orientation, immediate recall, serial subtraction of 7, reciting digits backward, recalling 3 words, recalling 5 objects, and word fluency (generating names of vegetables), with a maximum performance score of 30.[19] The FAB is designed to evaluate frontal functioning with a 6-item scale including conceptualization (similarities test), mental flexibility (lexical fluency), motor programming (Luria motor series, eg, fist–edge–palm test), conflicting instructions (sensitivity to interference), go–no go (inhibitory control), and prehension behavior (environmental autonomy), with a maximum performance score of 18.[20] The GDS involves a screening questionnaire for depression and anxiety in medical settings, with a maximum severity score of 15.[21,22] The VI is based on a 5-item scale including waking pattern, communication, feeding, on and off toilet, rehabilitation, and other activities, with a maximum performance score of 10.[23] The AS involves a questionnaire with scores ranging 0-42, with a criterion of 14 or more indicating apathy.[24]

Touch Panel Screening Test

A computerized touch panel–type screening test for the early diagnosis of dementia, called the "Ryokansan" (Ohtsu Computer Corp, Ohtsu, Japan) was tested with normal control and IS patients. The Ryokansan computer test uses a large touch panel screen, and does not require detailed manual-handling tasks such as writing. In the present study, we used the touch panel–type screening system to measure subjects' accuracy (%) in completing the "beating devils" game (Fig 1A) and the time taken (seconds) to complete picture arrangement (Fig 1B), flipping card (Fig 1C), and finding mistakes (Fig 1D) games. In the beating devils game, patients were instructed to distinguish between the emergence of heroes and devils, and we measured their accuracy in exterminating only