Table 3 Diagnostic performance

Variables	AUC (with 95% CI in parentheses)	Cut-off	Accuracy			
			SE	SP	PPV	LR+
AD versus HC						
MMSE	0.988 (0.976–0.999)***	24/25	85.6	100.0	100.0	–
CDT-command	0.912 (0.871–0.952)***	8/9	82.9	87.8	95.3	6.8
CDT-copy	0.764 (0.700–0.829)***	10	55.5	95.9	97.6	13.5
ADAS-J cog	0.989 (0.979–1.000)***	7.5/7.6	95.2	100.0	100.0	–
MMSE + CDT-command	0.997 (0.987–1.000)***	0.39	91.1	100.0	100.0	–
AD versus MCI						
MMSE	0.795 (0.730–0.860)***	23/24	74.7	68.3	85.2	2.4
CDT-command	0.711 (0.630–0.792)***	8/9	74.0	58.3	81.2	1.8
CDT-copy	0.686 (0.614–0.759)***	10	55.5	75.0	84.4	2.2
ADAS-J cog	0.806 (0.741–0.871)***	13.5/13.6	75.3	71.7	86.6	2.7
MMSE + CDT-copy	0.811 (0.747–0.875)***	0.67	75.3	70.0	85.9	2.5
MCI versus HC						
MMSE	0.837 (0.761–0.912)***	26/27	63.3	95.9	95.0	15.4
CDT-command	0.717 (0.622–0.812)***	8/9	50.0	87.8	83.4	4.1
CDT-copy	0.606 (0.501–0.711)	–	–	–	–	–
ADAS-J cog	0.893 (0.831–0.955)***	13.5/13.6	80.0	87.8	88.9	6.6

Notes: Values are AUC (with 95% CI in parentheses). ***$P < 0.001$.
Abbreviations: AUC, area under the curve; CI, confidence interval; SE, sensitivity; SP, specificity; PPV, positive predictive value; LR+, likelihood positive ratio; AD, Alzheimer's disease; HC, healthy controls; MMSE, Mini-Mental State Exam; CDT, Clock Drawing Test; ADAS-J cog, Japanese version of the Alzheimer's Disease Assessment Scale-cognitive subscale; MCI, mild cognitive impairment.

of 70.0%. The likelihood ratio of a positive test was 2.5. The positive predictive value was 85.9% with the prevalence of AD at 70.9% in the sample, according to the statistical coefficients shown (Table 3 and Figure 1). The equation used in logistic regression for differentiating between patients with AD and patients with MCI was:

$$10.09 - 0.23 \times \text{MMSE} - 0.44 \times \text{CDT-copy}. \quad (2)$$

The AUC in differentiating MCI group from HC group were 0.837 (CI = 0.761–0.912) for MMSE ($P < 0.001$), 0.717 (CI = 0.622–0.812) for CDT-command ($P < 0.001$), and 0.893 (CI = 0.831–0.955) for ADAS-J cog ($P < 0.001$) (Table 3). However, neither CDT-copy nor the combination of MMSE and CDT was identified by logistic regression analysis.

Discussion

We examined the abilities of a combination of the MMSE and the CDT administered according to different procedures against the ADAS-J cog alone to differentiate between patients with AD or MCI and HC. In differentiating patients with AD from HC, the combination of the CDT-command

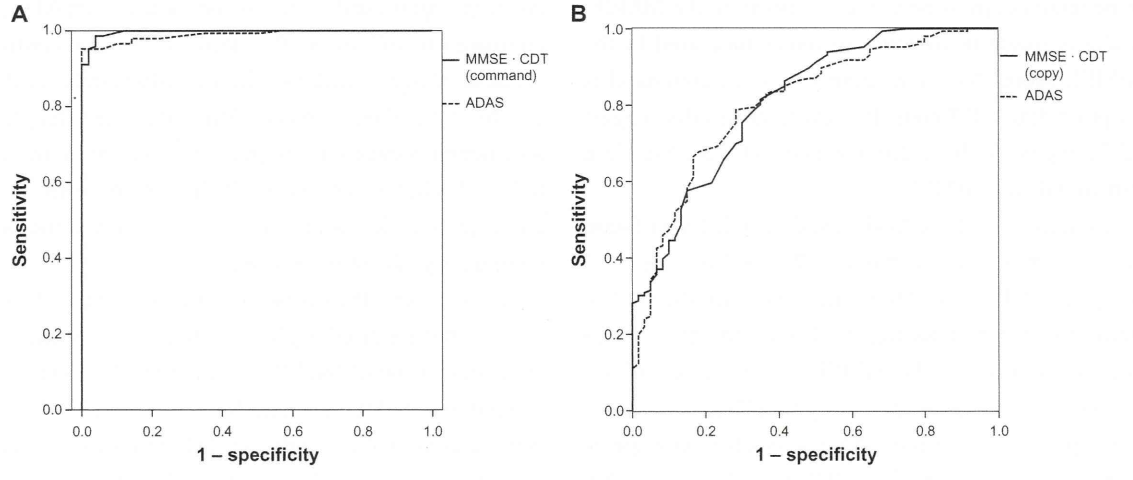

Figure 1 ROC curves. (**A**) Subjects with Alzheimer's disease versus healthy controls; (**B**) subjects with Alzheimer's disease versus mild cognitive impairment.
Abbreviation: ROC, receiver operating characteristic.

and the MMSE had better sensitivity and specificity, while a combination of the CDT-copy and the MMSE had better sensitivity and specificity in differentiating AD from MCI. The screening properties of these combinations were comparable to the ADAS-J cog.

When AD was compared to HC, the combination of the MMSE and the CDT-command was more sensitive than the MMSE alone, and has nearly the same sensitivity and specificity as the ADAS-J cog. These findings are consistent with previous studies that found enhanced accuracy in the detection of AD with the combined MMSE and CDT, as opposed to the MMSE or the CDT alone.[4–7] Heinik et al[6] showed that combining the MMSE and the CDT improved sensitivity to 100% and specificity to 91%, as compared with the MMSE alone (sensitivity, 96%; specificity, 81%). Further, this combination performed better than the Cognitive and self-contained part of the Cambridge Examination for Mental Disorders of the Elderly, a 30-minute multicognitive task.[13] We found that the MMSE combined with the CDT-command showed enhanced sensitivity as a first-stage dementia screen, as CDT-command requires multiple cognitive domains, such as receptive language, memory, abstraction, and executive functions.[3,13–15]

When patients with AD were compared to patients with MCI, the combination of the MMSE and the CDT-copy had better sensitivity and specificity than the MMSE or the CDT alone, and was nearly the same as that obtained with the ADAS-J cog. The CDT-copy mainly requires visuospatial and visuoconstructional function,[3,15] as with the double-pentagon copy of the MMSE. However, the CDT-copy might be more sensitive for measuring visuospatial and visuoconstructional functions than the double-pentagon copy, because the CDT-copy requires the spatial layout of the complex component features of a clock. In addition, the double-pentagon copy is only worth 1 point on the MMSE, and disability might be underestimated as measured by the total MMSE score. As a screening test, CDT-command is more popular than CDT-copy. However, our results suggest that CDT-copy is useful to differentiate AD from MCI if it is administered with MMSE.

The combination of the MMSE and the CDT was found to have a higher sensitivity than (89.4%) and the identical specificity of (83.9%) the MMSE alone (sensitivity, 86.4%; specificity, 83.9%) in detecting mild AD and MCI.[5] From our data, we found that the MMSE has good sensitivity (74.7%), but it lacks good specificity (68.3%); conversely, the CDT-copy lacks sensitivity (55.5%) but has high specificity (75.0%) in differentiating MCI from AD. Thus, this combination enhanced accuracy complementarily.

Hence, the combination of MMSE and CDT would be useful as one of the assessments when general practitioners evaluate dementia and decide timing to prescribe a cholinesterase inhibitor in a primary care or community setting.

On the other hand, the combination of the MMSE and the CDT was not able to accurately differentiate patients with MCI from HC in this study. Cacho et al[5] studied 66 individuals with mild AD, 21 individuals with MCI, and 66 HC individuals in a memory clinic, and found that the AUC for this combination (mini-clock) were higher than what was obtained using the MMSE or the CDT alone in differentiating patients with MCI from HC. Cacho et al[5] concluded that mini-clock assessment is reasonably accurate in distinguishing patients with MCI from HC; however, this study had small sample sizes, especially for patients with MCI. Only a few studies have tried to test the screening properties of this combination in differentiating between patients with MCI and HC. Hence, further research is necessary to conclude whether this combination can be used to differentiate patients with MCI from HC.

This study has several limitations. First, the MCI construct has still been controversial, and many types and stages of MCI have been proposed. We diagnosed subjects with MCI solely based on their informant-based functional status. However, some cases might possibly have met criteria for dementia if their functional status had been more strictly assessed. First, we should have defined stages of MCI, early or late MCI, and used the activities of daily living and instrumental activities of daily living to evaluate the functional autonomy of AD, not only MCI. Second, HC were significantly younger as compared to patients with MCI and AD. This may have enhanced sensitivity too much. However, it is noteworthy that cognitive scores for the MMSE, the CDT-command, and the ADAS-J cog were significantly worse in individuals with AD and MCI compared to HC, even after adjusting for the confounding variable of age. Third, we did not collect data on the level of education of our subjects. Since HC were sampled from a dementia prevention program, they might be more likely to have higher education levels than the patients. However, all subjects are known to have at least received the Japanese compulsory education of 6 years.

In summary, these results are consistent with previous studies that reported high sensitivity and specificity with the combination of the MMSE and the CDT when AD was compared with HC and with MCI. Our results also suggest that the combination of the MMSE and the CDT may be a similarly accurate replacement for the ADAS-J cog, which is to be used when screening time is limited.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Petersen RC, Smith GE, Waring SC, Ivnik RJ, Tangalos EG, Kokmen E. Mild cognitive impairment: clinical characterization and outcome. *Arch Neur*. 1999;56(6):303–308.
2. Mitchell AJ. A meta-analysis of the accuracy of the mini-mental state examination in the detection of dementia and mild cognitive impairment. *J Psychiatr Res*. 2009;43(4):411–431.
3. Shulman KI. Clock drawing: is it the ideal cognitive screening test? *Int J Geriatr Psychiatr*. 2000;15(6):548–561.
4. Aprahamian I, Martinelli JE, Cecato J, Yassuda MS. Screening for Alzheimer's disease among illiterate elderly: accuracy analysis for multiple instruments. *J Alzheimers Dis*. 2011;26(2):221–229.
5. Cacho J, Benito-León J, García-García R, Fernández-Calvo B, Vicente-Villardón JL, Mitchell AJ. Does the combination of the MMSE and clock drawing test (mini-clock) improve the detection of mild Alzheimer's disease and mild cognitive impairment? *J Alzheimers Dis*. 2010;22(3):889–896.
6. Heinik J, Solomesh I, Bleich A, Berkman P. Are the clock drawing test and the MMSE combined interchangeable with CAMCOG as a dementia evaluation instrument in a specialized outpatient setting? *J Geriatr Psychiatry Neurol*. 2003;16(2):74–79.
7. Schramm U, Berger G, Müller R, Kratzsch T, Peters J, Frölich L. Psychometric properties of clock drawing test and MMSE or Short Performance Test (SKT) in dementia screening in a memory clinic population. *Int J Geriatr Psychiatry*. 2002;17(3):254–260.
8. Rosen WG, Mohs RC, Davis KL. A new rating scale for Alzheimer's disease. *Am J Psychiatry*. 1984;141(11):1356–1364.
9. Homma A, Fukuzawa K, Tsukada Y, Ishii T, Hasegawa K, Mohs RC. Development of a Japanese version of Alzheimer's disease assessment scale (ADAS) (in Japanese). *Japanese Journal of Geriatric Psychiatry*. 1992; 3: 647–655.
10. McKhann G, Drachman D, Folstein M, Katzman R, Price D, Stadlan EM. Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology*. 1984;34(7):939–944.
11. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*. 1975;12(3):189–198.
12. Rouleau I, Salmon DP, Butters N, Kennedy C, McGuire K. Quantitative and qualitative analyses of clock drawings in Alzheimer's and Huntington's disease. *Brain Cogn*. 1992;18(1):70–87.
13. Roth M, Tym E, Mountjoy CQ, Huppert FA, Hendrie H, Verma S, Goddard R. CAMDEX. A standardised instrument for the diagnosis of mental disorder in the elderly with special reference to the early detection of dementia. *Br J Psychiatry*. 1986;149:698–709.
14. Royall DR, Mulroy AR, Chiodo LK, Polk MJ. Clock drawing is sensitive to executive control: a comparison of six methods. *J Gerontol B Psychol Sci Soc Sci*. 1999;54(5):P328–P333.
15. Freedman M, Leach L, Kaplan E, Winocur G, Shulman KI, Delis DC. *Clock Drawing: A Neuropsychological Analysis*. New York, NY: Oxford University Press; 1994.

International Psychogeriatrics (2013), 25:8, 1317–1323 © International Psychogeriatric Association 2013
doi:10.1017/S1041610213000690

Neural correlates of the components of the clock drawing test

Teruyuki Matsuoka,[1] Jin Narumoto,[1] Aiko Okamura,[1] Shogo Taniguchi,[1] Yuka Kato,[1] Keisuke Shibata,[1] Kaeko Nakamura,[1] Chio Okuyama,[2] Kei Yamada[2] and Kenji Fukui[1]

[1] *Department of Psychiatry, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, 465 Kajii-cho, Kawaramachi-Hirokoji, Kamigyo-ku, Kyoto 602-8566, Japan*
[2] *Department of Radiology, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, 465 Kajii-cho, Kawaramachi-Hirokoji, Kamigyo-ku, Kyoto 602-8566, Japan*

ABSTRACT

Background: The aim of this study was to identify the neural correlates of each component of the clock drawing test (CDT) in drug-naïve patients with Alzheimer's disease (AD) using single photon emission computed tomography.

Methods: The participants were 95 drug-naïve patients with AD. The Rouleau CDT was used to score the clock drawings. The score for the Rouleau CDT (R total) is separated into three components: the scores for the clock face (R1), the numbers (R2), and the hands (R3). A multiple regression analysis was performed to examine the relationship of each score (i.e. R total, R1, R2, and R3) with regional cerebral blood flow (rCBF). Age, gender, and education were included as covariates. The statistical threshold was set to a family-wise error (FWE)-corrected p value of 0.05 at the voxel level.

Results: The R total score was positively correlated with rCBF in the bilateral parietal and posterior temporal lobes and the right middle frontal gyrus. R1 was not significantly positively correlated with rCBF, R2 was significantly positively correlated with rCBF in the right posterior temporal lobe and the left posterior middle temporal lobe, and R3 was significantly positively correlated with rCBF in the bilateral parietal lobes, the right posterior temporal lobe, the right middle frontal gyrus, and the right occipital lobe.

Conclusions: Various brain regions were associated with each component of the CDT. These results suggest that an assessment of these components is useful for the detection of localization of brain damage.

Key words: clock drawing test, Alzheimer's disease, single photon emission computed tomography, statistical parametric mapping 8, drug-naïve patients

Introduction

Cognitive functions including visuospatial ability, executive function, comprehension, and semantic memory are necessary to complete the clock drawing test (CDT; Rouleau *et al.*, 1992; Royall *et al.*, 1998; Shulman, 2000; Leyhe *et al.*, 2009). Previously, we investigated the neural correlates of CDT performance using the free-drawn method and the pre-drawn method, with measurements using magnetic resonance imaging (MRI) voxel-based morphometry (Matsuoka *et al.*, 2011). Brain damage in the bilateral posterior temporal lobes was shown to affect performance on the pre-drawn method, whereas brain damage in the right posterior temporal lobe affected the free-drawn method. Thus, the study suggested that the different clock drawing methods evaluated different cognitive functions (Matsuoka *et al.*, 2011).

In addition to the use of different methods, the CDT can be evaluated quantitatively or qualitatively. More than a dozen different quantitative scoring systems for the CDT have been published (Shulman, 2000). Quantitative evaluation is easy to score; is relatively independent of culture, language, and education; and has achieved widespread clinical use for cognitive screening. We demonstrated that distinct brain regions might be associated with CDT performance using different quantitative scoring systems (Matsuoka *et al.*, 2011). These results suggested that the different quantitative scoring systems required different cognitive functions.

On the other hand, qualitative evaluation is useful for screening for dementia and in differentiating between dementia subtypes (Kitabayashi *et al.*,

Correspondence should be addressed to: Dr. Teruyuki Matsuoka, Department of Psychiatry, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, 465 Kajii-cho, Kawaramachi-Hirokoji, Kamigyo-ku, Kyoto 602-8566, Japan. Phone: +81-75-2515612; Fax: +81-75-2515839. Email: tmms2004@koto.kpu-m.ac.jp. Received 29 Dec 2012; revision requested 25 Mar 2013; revised version received 18 Apr 2013; accepted 22 Apr 2013. First published online 16 May 2013.

2001; Blair *et al.*, 2006; Lee *et al.*, 2008b). While conceptual and spatial and/or planning deficits were frequent in patients with Alzheimer's disease (AD), graphic difficulties were frequent in patients with mild to moderate vascular dementia (Kitabayashi *et al.*, 2001). This result suggested that the neural correlates of the different qualitative errors were distinct.

Few studies have investigated the relationship between qualitative deficits on the CDT and brain regions. Suhr *et al.* (1998) showed that qualitative scoring could be used to differentiate among stroke patients with different local lesions. In the study, the location of the lesions was roughly divided based on laterality, cortical or subcortical, and anterior or posterior. Therefore, the brain regions associated with the qualitative deficits on the CDT have not been fully investigated. Qualitatively, the CDT can be separated into three components: clock face representation, layout of the numbers, and position of the hands. The Rouleau CDT is designed to assess the accuracy of each of these components (Rouleau *et al.*, 1992). The purpose of this study was to identify neural correlates of each component of the Rouleau CDT using single photon emission computed tomography (SPECT) in patients with AD.

Methods

Participants

Ninety-five right-handed drug-naïve patients with AD (33 males, 62 females; mean age ± SD, 74.8 ± 8.2 years old) were recruited from the Center for Diagnosis of Dementia at the Kyoto Prefectural University of Medicine. All patients had been assessed comprehensively by a geriatric psychiatrist, received their information including medical and social histories, physical and neurological examinations, neuropsychological tests, laboratory data, and brain imaging. Cognitive impairments were assessed by clinical examination and neuropsychological tests, and functional status was confirmed by family members or other available caregivers. The diagnosis was made according to the National Institute of Neurological and Communicative Disease and Stroke–Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA) criteria for probable AD (McKhann *et al.*, 1984). Patients were excluded from the study if they had a significant history of psychiatric or neurological disorders (other than AD), including stroke, head injury, epilepsy, psychiatric disorders, alcohol abuse, or a serious medical condition. None of the patients had been prescribed anti-dementia or other psychoactive drugs because our center examines patients who have not been diagnosed with dementia. The ethics committee of the Kyoto Prefectural University of Medicine approved the study and informed consent was obtained from all participants.

Neuropsychological tests

All patients with AD were evaluated using the CDT and the Mini-Mental State Examination (MMSE; Folstein *et al.*, 1975). For the CDT, patients were presented with a blank sheet of paper and a pencil and given the following instructions: "I would like you to draw a clock, put in all the numbers, and set the hands at 20 past 8." The free-drawn clock drawings were scored using the Rouleau CDT on a 10-point scale (Rouleau *et al.*, 1992), with higher scores reflecting better CDT performance. This 10-point scale (R total) is designed to assess the accuracy of the clock face representation (R1, maximum 2 points), the layout of the numbers (R2, maximum 4 points), and the position of the hands (R3, maximum 4 points). Two raters (T.M. and A.O.) blinded to the clinical data independently scored all the drawings. The inter-rater reliability was examined by calculation of intraclass correlation coefficients (ICCs) based on the rating of all patients by the two raters. The inter-rater ICCs for the R total, R1, R2, and R3 scores were all >0.942. All drawings were reassessed after at least four weeks by one rater (T.M.) and the intra-rater ICCs for the four scores were all >0.955.

Image acquisition

All patients with AD underwent brain perfusion SPECT within one month after they underwent MMSE and CDT. SPECT was performed by intravenous injection of 185 MBq of N-isopropyl-p-[^{123}I]iodoamphetamine (I-123-IMP) (Nihon Mediphysics, Hyogo, Japan) in participants seated at rest with their eyes open. SPECT imaging commenced 22 minutes after the injection and continued for 16 minutes. A triple-head gamma camera (PRISM IRIX, Picker International, Cleveland, OH, USA) equipped with low-energy, high-resolution, parallel collimators was used. Projection data from each camera were obtained in a 128×128 format for 40 steps of 120° at 8 seconds per step (voxel size: $2 \times 2 \times 2$ mm).

Image analysis was performed using Statistical Parametric Mapping (SPM) 8 (Wellcome Department of Cognitive Neurology, University College, London) in Matlab 7.5 (Mathworks Inv., Sherborn, MA, USA). The acquired SPECT images were converted from DICOM to Analyze format using MRIcro (http://www.mricro.com) and transferred to SPM8. After confirmation of no significant

Table 1. Clinical characteristics of patients (n = 95) with Alzheimer's disease

ITEM	VALUE
Sex, male/female	33/62
Age, years	74.8 ± 8.2
Education, years	10.7 ± 2.9
Mini-Mental State Examination score	20.1 ± 4.8
R total	6.3 ± 2.5
R1 (clock face)	1.6 ± 0.7
R2 (numbers)	2.3 ± 1.3
R3 (hands)	2.2 ± 1.2

Except for sex, data are shown as the mean ± standard deviation.

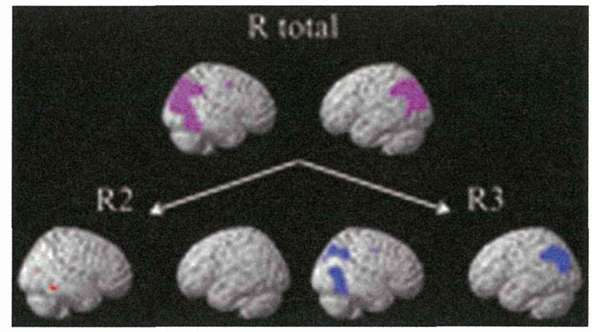

Figure 1. (Colour online) Regions in which rCBF showed a positive correlation with each CDT score (purple, R total; red, R2; blue, R3) for statistical thresholds set to an FWE-corrected p value of 0.05 at the voxel level.

artifacts using MRI or computed tomography (CT), all SPECT images were anatomically normalized using the I-123-IMP template (Fujifilm RI Pharma, Tokyo, Japan) matched to the Montreal Neurological Institute (MNI) template. The normalized images were smoothed using a 12-mm full-width half-maximum isotropic Gaussian kernel. To examine regional differences, the images were scaled to a mean global cerebral blood flow of 50 mL/100 g/min.

Statistical analyses

A multiple regression analysis was performed to detect a relationship between each score (R total, R1, R2, and R3) and regional cerebral blood flow (rCBF) in the patients with AD. Age, gender, and education were included as covariates. The X, Y, and Z coordinates provided by SPM were used to approximate the MNI brain space. Statistical thresholds were set to a family-wise error (FWE)-corrected p value of 0.05 at the voxel level in all analyses.

Results

Characteristics of patients

Table 1 shows the characteristics of the patients with AD. Although the MMSE score ranged from 5 to 28, the mean MMSE score was 20.1 ± 4.8, and the cognitive dysfunction in most of the patients with AD ranged from mild to moderate. The R1 score (maximum 2 points) was relatively high, whereas R2 (maximum 4 points) and R3 (maximum 4 points) were relatively low.

Multiple regression analysis

The multiple regression analysis showed a positive correlation between R total and rCBF in the bilateral parietal and posterior temporal lobes and the right middle frontal gyrus (Table 2). R1 was not significantly positively correlated with rCBF, R2 was significantly positively correlated with rCBF in the right posterior temporal lobe and the left posterior middle temporal lobe, and R3 was significantly positively correlated with rCBF in the bilateral parietal lobes, the right posterior temporal lobe, the right middle frontal gyrus, and the right occipital lobe (Figure 1 and Table 2).

Discussion

In this study, we found that performances on two different components of the CDT, numbers and hands, were associated with rCBF in various brain regions, including the parietal, temporal, and frontal lobes. These brain regions showed both overlap and differences between the CDT components. The results support that the analysis of the components of the CDT is useful for the assessment of localization of brain damage and differential diagnosis.

Regarding the performance on the drawing of the clock hands, we identified a correlation with the right middle frontal gyrus, in addition to those with the bilateral parietal lobes and right posterior temporal lobe, which have been repeatedly reported in previous studies (Lee *et al.*, 2008a; Matsuoka *et al.*, 2011). Ino *et al.* (2003) showed that drawing the hands of a clock corresponding to the time presented acoustically was related to brain areas including the bilateral posterior parietal lobes and bilateral dorsal premotor areas. Seidl *et al.* (2012) showed that performance on the Shulman CDT, using the pre-drawing method and assessing only the numbers and hands, was associated with impairment in the bilateral hippocampus and right globus pallidus. The dorsolateral prefrontal circuit including the dorsolateral prefrontal and globus pallidus plays a role in the organization of

Table 2. Results of the multiple regression analysis

BRAIN AREA	MNI COORDINATES AT THE CENTER OF THE CLUSTER			Z VALUE AT THE LOCAL MAXIMUM	VOXEL P VALUE (CORRECTED)	CLUSTER SIZE	CLUSTER P VALUE (CORRECTED)
	X	Y	Z				
R total							
Left parietal and posterior temporal lobe	−28	−70	38	5.35	<0.001	4376	<0.001
Right parietal and posterior temporal lobe	48	−72	12	5.28	0.001	5416	<0.001
Right middle frontal gyrus	34	−4	48	4.23	0.018	107	0.024
R2 (numbers)							
Right posterior temporal lobe	44	−50	−14	4.34	0.012	29	0.037
	34	−50	−12	4.13	0.026	9	0.044
	50	−78	12	3.96	0.047	6	0.045
Left posterior middle temporal lobe	−44	−80	16	3.94	0.049	1	0.048
R3 (hands)							
Left parietal lobe	−34	−66	38	4.94	0.001	3047	<0.001
Right posterior temporal lobe	50	−66	10	4.69	0.003	1274	0.001
Right parietal lobe	50	−52	40	4.25	0.017	676	0.004
Right middle frontal gyrus	36	−6	46	4.06	0.034	41	0.034
Right occipital lobe	10	−58	2	3.97	0.046	5	0.045

information to facilitate a response (Bonelli and Cummings, 2007. In addition, a spatial working memory task activates a dorsal pathway distributed between the parieto-occipital and dorsal prefrontal cortex, predominantly in the right hemisphere (Ventre-Dominey *et al.*, 2005). Other studies have suggested involvement of the fronto-parietal network in visuomotor control (Wise *et al.*, 1997) and attention control (Neufang *et al.*, 2011). Therefore, the present results suggest that the performance on the drawing of the clock hands in the CDT requires executive function, spatial working memory, and visuomotor and attention control, which are supported by the fronto-parietal network. Moreover, the present results show that the right posterior temporal lobe, involved in visual knowledge (Owen *et al.*, 1996; Kellenbach *et al.*, 2001) and spatial attention (Chen *et al.*, 2009), also plays an important role for the drawing of the clock hands.

The performance on the drawing of the clock numbers was mainly affected by dysfunction of the right posterior temporal lobe. In previous lesion studies, impaired spatial organization, including impaired number placement and/or omission of numbers, was much more frequent in participants with right hemisphere lesions (Suhr *et al.*, 1998; Tranel *et al.*, 2008). Moreover, a SPECT study showed that a reversed CDT phenomenon, which is an error in the layout of the numbers, was associated with right fronto-temporal dysfunction (Brugnolo *et al.*, 2010). The right posterior temporal lobe plays a role in retrieval of visual knowledge (Owen *et al.*, 1996; Kellenbach *et al.*, 2001) and spatial attention (Chen *et al.*, 2009), and the performance on the drawing of the clock numbers in the CDT might reflect these cognitive functions.

The importance of the performance on the drawing of the numbers and hands in the CDT is still uncertain. Some studies have shown that the assessment of numbers and hands has a higher discriminatory power than the assessment of numbers only (Brodaty and Moore, 1997; Storey *et al.*, 2001; Schramm *et al.*, 2002), whereas other studies indicate that only a number assessment was useful to detect cognitive impairment in patients with dementia and mild cognitive impairment (Lee *et al.*, 2008b; Jouk and Tuokko, 2012). In this study, we identified both common and distinct brain regions associated with performance on the drawing of the numbers and hands. Therefore, a combination of these assessments can cover broader brain regions than the assessment of each component alone.

Finally, the total score for the CDT was significantly positively correlated with rCBF in the bilateral parietal and posterior temporal lobes and the right middle frontal gyrus. Previous studies have shown that the Rouleau CDT is associated with the right parietal lobe (Lee *et al.*, 2008a; Matsuoka *et al.*, 2011), the right posterior inferior temporal lobe (Matsuoka *et al.*, 2011), the left hippocampus (Takahashi *et al.*, 2008; Matsuoka *et al.*, 2011), and the left posterior temporal lobe (Ueda *et al.*, 2002). Therefore, the total score on the Rouleau CDT appears mainly to reflect the function of the bilateral posterior temporal lobes and the right parietal lobe, including visuospatial ability and semantic memory.

There were a large number of participants in the study and all were drug-naïve. However, the study still has some limitations. First, we failed to show a region that was significantly correlated with performance on the drawing of the clock face. This may be because the cognitive dysfunction in most of the patients ranged from mild to moderate and most patients were able to draw an acceptable clock face, leading to a skewed data distribution. However, this suggests that the drawing of the clock face has no influence on the performance of numbers and hands. Second, we used the CDT instructions "set the hands at 20 past 8" although the original Rouleau CDT used the instructions "set the hands for 10 after 11." It has been considered that "10 after 11" may be more sensitive to frontal dysfunction including stimulus bound responses as the "10" has both concrete and abstract representations on the clock. For "20 past 8," the participant must recode the "20" as "4." Moreover, some patients with frontal lobe deficits set the minute hand at the "2" because the "2" most closely resembles the "20" (Freedman *et al.*, 1994). In this study, the performance on the drawing of the hands was associated with the right middle frontal gyrus. Therefore, the instructions "set the hands at 20 past 8" may also be sensitive to frontal dysfunctions. Third, the data for the healthy participants lacked. Fourth, we performed multiple regression analyses using only functional images. Fifth, the assessment of the vascular lesions might be insufficient although the patients with apparent cerebral vascular disease were excluded using MRI or CT. Thus, an interpretation of our results should be performed within these limitations and requires caution. Additional studies are necessary to examine the neural correlates of the components of CDT performance.

In summary, various brain regions were associated with different components of the CDT. These results suggest that the assessment of each of these components might be useful for the detection of localization of brain damage.

Conflict of interest

None.

Description of authors' roles

T. Matsuoka designed the study, analyzed the data, and wrote the paper. J. Narumoto designed the study, supervised the data collection, and assisted with writing the paper. A. Okamura scored the CDT and assisted with writing the paper. S. Taniguchi, Y. Kato, K. Shibata, and K. Nakamura collected the data and assisted with writing the paper. C. Okuyama and K. Yamada collected the image data and assisted with writing the paper. K. Fukui supervised the study and assisted with writing the paper.

Acknowledgments

None.

References

Blair, M., Kertesz, A., Mcmonagle, P., Davidson, W. and Bodi, N. (2006). Quantitative and qualitative analyses of clock drawing in frontotemporal dementia and Alzheimer's disease. *Journal of the International Neuropsychological Society*, 12, 159–165.

Bonelli, R. M. and Cummings, J. L. (2007). Frontal-subcortical circuitry and behavior. *Dialogues in Clinical Neuroscience*, 9, 141–151.

Brodaty, H. and Moore, C. M. (1997). The clock drawing test for dementia of the Alzheimer's type: a comparison of three scoring methods in a memory disorders clinic. *International Journal of Geriatric Psychiatry*, 12, 619–627.

Brugnolo, A. *et al.* (2010). The reversed clock drawing test phenomenon in Alzheimer's disease: a perfusion SPECT study. *Dementia and Geriatric Cognitive Disorders*, 29, 1–10.

Chen, Q., Marshall, J. C., Weidner, R. and Fink, G. R. (2009). Zooming in and zooming out of the attentional focus: an FMRI study. *Cerebral Cortex*, 19, 805–819.

Folstein, M. F., Folstein, S. E. and Mchugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12, 189–198.

Freedman, M., Leach, L., Kaplan, E., Winocur, G., Shulman, K. I. and Delis, D. C. (1994). *Clock Drawing: A Neuropsychological Analysis*. New York: Oxford University Press.

Ino, T., Asada, T., Ito, J., Kimura, T. and Fukuyama, H. (2003). Parieto-frontal networks for clock drawing revealed with fMRI. *Neuroscience Research*, 45, 71–77.

Jouk, A. and Tuokko, H. (2012). A reduced scoring system for the clock drawing test using a population-based sample. *International Psychogeriatrics*, 24, 1738–1748.

Kellenbach, M. L., Brett, M. and Patterson, K. (2001). Large, colorful, or noisy? Attribute- and modality-specific activations during retrieval of perceptual attribute knowledge. *Cognitive, Affective, and Behavioral Neuroscience*, 1, 207–221.

Kitabayashi, Y., Ueda, H., Narumoto, J., Nakamura, K., Kita, H. and Fukui, K. (2001). Qualitative analyses of clock drawings in Alzheimer's disease and vascular dementia. *Psychiatry and Clinical Neurosciences*, 55, 485–491.

Lee, D. Y. *et al.* (2008a). Neural correlates of the clock drawing test performance in Alzheimer's disease: a FDG-PET study. *Dementia and Geriatric Cognitive Disorders*, 26, 306–313.

Lee, K. S., Kim, E. A., Hong, C. H., Lee, D. W., Oh, B. H. and Cheong, H. K. (2008b). Clock drawing test in mild cognitive impairment: quantitative analysis of four scoring methods and qualitative analysis. *Dementia and Geriatric Cognitive Disorders*, 26, 483–489.

Leyhe, T. *et al.* (2009). Changes in cortical activation during retrieval of clock time representations in patients with mild cognitive impairment and early Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, 27, 117–132.

Matsuoka, T. *et al.* (2011). Neural correlates of performance on the different scoring systems of the clock drawing test. *Neuroscience Letters*, 487, 421–425.

Mckhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D. and Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology*, 34, 939–944.

Neufang, S. *et al.* (2011). Disconnection of frontal and parietal areas contributes to impaired attention in very early Alzheimer's disease. *Journal of Alzheimer's Disease*, 25, 309–321.

Owen, A. M., Milner, B., Petrides, M. and Evans, A. C. (1996). Memory for object features versus memory for object location: a positron-emission tomography study of encoding and retrieval processes. *Proceedings of the National Academy of Sciences of the United States of America*, 93, 9212–9217.

Rouleau, I., Salmon, D. P., Butters, N., Kennedy, C. and Mcguire, K. (1992). Quantitative and qualitative analyses of clock drawings in Alzheimer's and Huntington's disease. *Brain and Cognition*, 18, 70–87.

Royall, D. R., Cordes, J. A. and Polk, M. (1998). CLOX: an executive clock drawing task. *Journal of Neurology, Neurosurgery, and Psychiatry*, 64, 588–594.

Schramm, U., Berger, G., Muller, R., Kratzsch, T., Peters, J. and Frolich, L. (2002). Psychometric properties of clock drawing test and MMSE or Short Performance Test (SKT) in dementia screening in a memory clinic population. *International Journal of Geriatric Psychiatry*, 17, 254–260.

Seidl, U. *et al.* (2012). Subcortical morphological correlates of impaired clock drawing performance. *Neuroscience Letters*, 512, 28–32.

Shulman, K. I. (2000). Clock-drawing: is it the ideal cognitive screening test? *International Journal of Geriatric Psychiatry*, 15, 548–561.

Storey, J. E., Rowland, J. T., Basic, D. and Conforti, D. A. (2001). A comparison of five clock scoring methods using ROC (receiver operating characteristic) curve analysis. *International Journal of Geriatric Psychiatry*, 16, 394–399.

Suhr, J., Grace, J., Allen, J., Nadler, J. and Mckenna, M. (1998). Quantitative and qualitative performance of stroke versus normal elderly on six clock drawing systems. *Archives of Clinical Neuropsychology*, 13, 495–502.

Takahashi, M. *et al.* (2008). Poor performance in clock-drawing test associated with visual memory deficit and reduced bilateral hippocampal and left temporoparietal regional blood flows in Alzheimer's disease patients. *Psychiatry and Clinical Neurosciences*, 62, 167–173.

Tranel, D., Rudrauf, D., Vianna, E. P. and Damasio, H. (2008). Does the clock drawing test have focal neuroanatomical correlates? *Neuropsychology*, 22, 553–562.

Ueda, H. *et al.* (2002). Relationship between clock drawing test performance and regional cerebral blood flow in Alzheimer's disease: a single photon emission computed tomography study. *Psychiatry and Clinical Neurosciences*, 56, 25–29.

Ventre-Dominey, J. *et al.* (2005). Double dissociation in neural correlates of visual working memory: a PET study. *Brain Research. Cognitive Brain Research*, 25, 747–759.

Wise, S. P., Boussaoud, D., Johnson, P. B. and Caminiti, R. (1997). Premotor and parietal cortex: corticocortical connectivity and combinatorial computations. *Annual Review of Neuroscience*, 20, 25–42.

Table 1. Clinical presentation and diagnosis of sporadic Creutzfeldt–Jakob disease

	Phase of disease progression			
	Prodromal	Early phase	Intermediate phase	Late phase
Duration	6 months	3–4 weeks	2 weeks	Months
Institutional care	Outpatient care	Psychiatric ward	Neurologic ward	Neurologic ward + palliative care
Psychiatric symptoms	Depression, anhedonia	Major depressive disorder: a propensity to cry, weight loss, insomnia	Mood disorder with psychotic symptoms: emotional lability, hypertalkativeness, referential delusions	Rapid progressive dementia with psychotic symptoms
Neurological symptoms	Negative	Negative	Weakness Myoclonic jerks Poor speech ability Urinary incontinence	Progressive immobility Akinetic mutism
Investigations	–	Brain CT :no apparent abnormal finding/ Normal standard biology	Brain MRI: hyperintensity of basal ganglia Non-specific EEG changes	Periodic EEG complex Western blot for 14-3-3 protein in CSF
CJD diagnosis	–	–	+	+

CJD, Creutzfeldt-Jakob disease; CSF, cerebrospinal fluid; CT, computed tomography; EEG, electroencephalogram; MRI, magnetic resonance imaging.

REFERENCES

1. Knight R. Creutzfeldt-Jakob disease: A rare cause of dementia in elderly persons. *Clin. Infect. Dis.* 2006; **43**: 340–346.
2. Zerr I, Kallenberg K, Summers DM *et al.* Updated clinical diagnostic criteria for sporadic Creutzfeldt-Jakob disease. *Brain* 2009; **132**: 2659–2668.
3. Will RG, Ward HJ. Clinical features of variant Creutzfeldt-Jakob disease. *Curr. Top. Microbiol. Immunol.* 2004; **284**: 121–132.
4. Wall CA, Rummans TA, Aksamit AJ, Krahn LE, Pankratz VS. Psychiatric manifestations of Creutzfeldt-Jakob disease: A 25-year analysis. *J. Neuropsychiatry Clin. Neurosci.* 2005; **17**: 489–495.
5. Nozaki I, Hamaguchi T, Sanjo N *et al.* Prospective 10-year surveillance of human prion diseases in Japan. *Brain* 2010; **133**: 3043–3057.
6. Dunn NR, Alfonso CA, Young RA, Isakov G, Lefer J. Creutzfeldt-Jakob disease appearing as paranoid psychosis. *Am. J. Psychiatry* 1999; **156**: 2016–2017.
7. Lendvai I, Saravay SM, Steinberg MD. Creutzfeldt-Jakob disease presenting as secondary mania. *Psychosomatics* 1999; **40**: 524–525.
8. Jardri R, DiPaola C, Lajugie C, Thomas P, Goeb JL. Depressive disorder with psychotic symptoms as psychiatric presentation of sporadic Creutzfeldt-Jakob disease: A case report. *Gen. Hosp. Psychiatry* 2006; **28**: 452–454.
9. Collins SJ, Sanchez-Juan P, Masters CL *et al.* Determinants of diagnostic investigation sensitivities across the clinical spectrum of sporadic Creutzfeldt-Jakob disease. *Brain* 2006; **129**: 2278–2287.
10. Young GS, Geschwind MD, Fischbein NJ *et al.* Diffusion-weighted and fluid-attenuated inversion recovery imaging in Creutzfeldt-Jakob disease: High sensitivity and specificity for diagnosis. *AJNR Am. J. Neuroradiol.* 2005; **26**: 1551–1562.
11. Meissner B, Kallenberg K, Sanchez-Juan P *et al.* MRI lesion profiles in sporadic Creutzfeldt-Jakob disease. *Neurology* 2009; 72: 1994–2001.

Hsin-Yu Yang MD,[1,3] Shiau-Shian Huang, MD,[2,4]
Chih-Chien Lin, MD, MPH,[2,3,7] Tsuo-Hung Lan, MD, PhD[2,5,7]
and Chin-Hong Chan, MD, MAM[2,6,8]
Departments of [1]Family Medicine and [2]Psychiatry, Taichung Veterans General Hospital, [3]China Medical University, [4]Chung Shan Medical University, Taichung, [5]School of Medicine, National Yang-Ming University, [6]School of Medicine, National Defense University, Taipei, Taiwan, [7]John Hopkins University, Baltimore and [8]University of Wisconsin, Madison, USA
Email: s001007@hotmail.com
Received 3 May 2011; revised 18 December 2011; accepted 14 March 2012.

Case of dementia with Lewy bodies that progressed from schizoaffective disorder

doi:10.1111/pcn.12044

DIAGNOSING DEMENTIA IN the course of a psychotic disorder is often diffcult.[1] We encountered a case of dementia with Lewy bodies (DLB) that had progressed from a schizoaffective disorder.

Psychiatry and Clinical Neurosciences 2013; **67**: 280–282

The patient was a 60-year-old right-handed man. When he was 52, he had retired because of a downturn of the company. At 53 years of age, he developed delusions of pursuit and control and auditory hallucinations with no prominent affective symptoms and was successfully treated with olanzapine (20 mg/day). At 55, he became alternately depressive and hypomanic without exacerbation of pathological perceptions or occurrence of cognitive disturbance (his Revised Hasegawa's Dementia Scale score was 27/30). He was diagnosed as having schizoaffective disorder and was successfully treated with risperidone (4 mg/day) and lithium carbonate (600 mg/day). Magnetic resonance imaging (MRI) and single photon emission computed tomography (SPECT), performed when he was 57, did not show any significant findings.

When he was 59, his delusions acutely exacerbated without any change in medication. He developed mild memory disturbance and extrapyramidal symptoms (EPS) and was admitted to the psychiatric ward in our University Hospital.

His delusions did not improve with risperidone (9 mg/day) and biperiden (6 mg/day) treatment, and his EPS rapidly exacerbated. We replaced risperidone with quetiapine (750 mg/day) and blonanserin (24 mg/day) in the 7th and 11th week of hospitalization, respectively, but visual hallucinations without altered consciousness, delusion of theft, repeated falls, and night-time wandering developed. Further, he developed fluctuating cognitive dysfunctions, including daytime drowsiness, lethargy and disorganized speech. His Mini-Mental State Examination score was 16–26. MRI yielded no significant finding, whereas SPECT showed significantly decreased regional cerebral blood flow in the occipital lobe. Furthermore, early and delayed images of ^{123}I-meta-iodobenzylguanidine (MIBG) myocardial scintigraphy showed significantly impaired myocardial uptake.

The patient's clinical course fulfilled the criteria for probable DLB. We replaced blonanserin with aripiprazole (24 mg/day) and discontinued biperiden in the 26th week, and his visual hallucinations, delusions, and hand tremor remarkably improved. Donepezil (5 mg/day) treatment started in the 33rd week gradually improved the cognitive dysfunction fluctuation and night-time wandering, and he was discharged in the 46th week.

In this case, early clinical diagnosis of DLB was difficult. His clinical symptoms before age 59 might have been prodromes of DLB, because his onset of schizoaffective disorder, at 53, was unusually late. Finally, we confirmed the diagnosis on considering the clinical symptoms, including the shift in the nature of delusions (from the delusion of pursuit to theft) and neuroimaging findings. Moreover, psychotic symptoms, together with EPS, were successfully treated by subsequent change in medication, namely combination of donepezil and aripiprazole. Transient delirium, psychotic symptoms, and sedative effect of antipsychotics may also cause fluctuation of cognitive function. However, because visual hallucinations had occurred without altered consciousness, these could not be explained only by delirium. The unexpected exacerbation of psychiatric symptoms and EPS after various antipsychotics, except aripiprazole, indicated neuroleptic sensitivity. Although antipsychotics can influence the results of MIBG scintigraphy, longitudinal results of MRI and SPECT supported the diagnosis of DLB. The discontinuance of anticholinergics and introduction of aripiprazole (mild anticholinergic) and cholinesterase inhibitor, which enhanced cholinergic transmission, might have improved both cognitive and psychiatric symptoms.

REFERENCE

1. Kitabayashi Y, Narumoto J, Fukui K. Neurodegenerative disorders in schizophrenia. *Psychiatry Clin. Neurosci.* 2007; **61**: 574–575.

Naoko Iida, MD,[1] Keisuke Shibata, MD, PhD,[2]
Yuri Nagahara, MD,[1] Aiko Okamura, MD, PhD,[1]
Teruyuki Matsuoka, MD, PhD,[1] Takashi Nakamae, MD, PhD,[1]
Jin Narumoto, MD, PhD[1] and Kenji Fukui, MD, PhD[1]
[1]*Department of Psychiatry, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto and* [2]*Gojouyama Hospital, Nara, Japan*
Email: n-iida@koto.kpu-m.ac.jp
Received 17 May 2012; revised 20 January 2013; accepted 28 March 2013.

症例報告

認知機能障害により医療行為における同意能力が問題となった2例

—— MacCAT-T を用いた医療同意能力の評価について ——

加藤佑佳[*1,8]・松岡照之[*1,8]・小川真由[*1,8]・谷口将吾[*1,6]・藤本 宏[*1,3]
占部美恵[*2,8]・柴田敬祐[*3]・中村佳永子[*1]・江口洋子[*4,8]・飯干紀代子[*5,8]
小海宏之[*6,8]・仲秋秀太郎[*7,8]・三村 將[*7,8]・福居顯二[*1]・成本 迅[*1,8]

＊1 京都府立医科大学大学院医学研究科精神機能病態学，＊2 京都府立医科大学医学部看護学科，＊3 川越病院
＊4 放射線医学総合研究所，＊5 志學館大学人間関係学部心理臨床学科，＊6 花園大学社会福祉学部臨床心理学科
＊7 慶應義塾大学医学部精神・神経科学教室，＊8 RISTEX, JST

抄録

【目的】身体疾患に対する医療行為を受ける必要がある認知機能が低下した患者2例に MacArthur Competence Assessment Tool-Treatment（MacCAT-T）で医療同意能力を評価し，考察を加えて報告した．【症例1】80歳女性．右乳がんの治療目的で入院となった．認知機能障害が顕著で痛みの自覚がなく，手術への同意は変動していた．MacCAT-T の成績は低く手術の必要性について理解が得られず，同意能力は不十分と考えられた．最終的には本人と家族の同意を得て手術に至った．【症例2】56歳男性．正常圧水頭症の診断と治療のため入院となった．軽度認知機能障害があるものの，診断名，症状，手術で歩行障害が改善することの利点を平易な言葉で理解しており，MacCAT-T による評価では同意能力が保たれていると考えられた．【考察】同意能力の評価は認知機能レベル，精神症状，治療の選択肢の複雑さ，自覚症状の度合いなどを多角的に評価することが重要である．患者の医療行為への理解には変動があり，繰り返し評価する必要性も示唆された．

Key words：認知症，高齢者，医療同意能力，認知機能検査，MacArthur Competence Assessment Tool-Treatment (MacCAT-T)

老年精神医学雑誌 24：928-936，2013

序　言

最近の報告によると，現在わが国における認知症患者数は推計約462万人に上り，すでに65歳以上人口の15%に達しているとされる[16]．超高齢社会を迎え，認知機能が低下して自分で医療の必要性を判断することが難しくなった高齢者に対して，どのように医療を提供するのかが社会問題となってきている．医療慣行として，家族から同意をとってさまざまな医療行為が行われてきたが，代わりに同意をしてくれる身寄りがいない事例や，家族間に葛藤があり必要な治療が受けられない事例も存在する[13]．認知症という病名から同意能力なしと判断され，本人の意思が尊重されなかったり，同意能力が低下しているのにもかかわらず安易に得た同意に基づいて医療行為が開始されたりすることがあってはならない．こうした現状を踏まえ，適切に同意能力を評価して本人の意思を尊重した医療を実践できるよう，信頼性，妥当性が高く，現場で運用可能な評価ツールの開発が求められている．

そこで今回，筆者らは身体疾患に対する医療行為を受ける必要がありながらも，認知機能障害のために医療行為への同意能力低下が懸念された患者2例に，MacArthur Competence Assessment Tool-Treatment（MacCAT-T）[3]を用いて医療同意能力の評価を行った．これらの症例を通じて認知機能の低下を伴う高齢者の医療同意とその評価方法について考察し，今後の課題を検討したい．

なお，症例報告にあたっては個人が特定されないよう十分な倫理的配慮を行い，論文発表に関して2症例ともに本人および家族の同意を口頭で得た．

（受付日　2013年7月22日／受理日　2013年8月23日）
Yuka Kato, Teruyuki Matsuoka, Mayu Ogawa, Shogo Taniguchi, Hiroshi Fujimoto, Mie Urabe, Keisuke Shibata, Kaeko Nakamura, Yoko Eguchi, Kiyoko Iiboshi, Hiroyuki Koumi, Shutaro Nakaaki, Masaru Mimura, Kenji Fukui, Jin Narumoto
＊1 〒602-8566　京都府京都市上京区河原町通広小路上る梶井町465

I．MacCAT-T

MacCAT-T は同意能力の構成要素である「理解（understanding）」「認識（appreciation）」「論理的思考（reasoning）」「選択の表明（expressing a choice）」の4領域を評価することのできる半構造化面接法であり，同時に，医療者が患者に疾患と治療の選択肢を情報開示する指針ともなる[3]．こうした同意能力の評価方法が作成された背景としては，インフォームド・コンセントの浸透とともに同意能力が保たれている患者の自己決定が重視されるものの，肝心の同意能力の判定が臨床家によって大きく異なるという問題を踏まえ，医療同意能力という抽象的な概念を規定する操作的基準を設けようとしたことが挙げられる[8]．これまでにもいくつか評価方法が発表されてきたが，厳密で複雑な採点基準を要する評価方法を臨床場面で行うには限界があり，患者の個別性に合わせることも難しいという観点から，より現場で使用しやすい評価方法として Grisso ら[3]により作成された．所要時間は20分程度と比較的簡便であり，仮想の状態ではなく，患者それぞれの疾患，医療の選択肢に応じて同意能力を評価できるよう設計されている．評価は，各4領域の下位項目の質問についてそれぞれ0〜2点の3段階で評価し，総得点は「理解（6点満点）」「認識（4点満点）」「論理的思考（8点満点）」「選択の表明（2点満点）」とそれぞれの領域別に採点され，得点が高いほど能力が高いことを示す．カットオフ得点は設定されておらず，総合的な同意能力については，4領域の得点を踏まえて総合的に判定する必要がある．表1に，MacCAT-T における同意能力の評価基準と質問例を掲載した．

MacCAT-T の評価者間信頼性は0.73〜0.99と高い値が報告されており[1〜3,17]，海外では入院中の統合失調症や統合失調感情障害患者[2]，地域在住の健常高齢者や軽度認知症患者[9]，精神科急性期治療病棟の入院患者[11]，思春期の神経性食欲不振症患者[17]，国内では高齢がん患者[1]や慢性腎臓病患者[15]を対象に MacCAT-T を用いて同意能力を評価した研究が報告されている．ただし，詳細な認知機能検査との関連性についてはまだ十分な報告はなされておらず，検討する余地はある．

II．症　例

〈症例1〉80歳，女性

● 診断

統合失調症，アルツハイマー型認知症

● 生活歴

25歳ごろに医学部を卒業し小児科医として働いていたが，徐々に精神病症状が明らかとなり，37歳ごろよりA病院精神科外来で統合失調症の診断を受け，ハロペリドール，リスペリドン，クエチアピンを投薬されていた．70歳時に右乳がんが見つかり，B病院にて右乳房温存手術を受けた．このころから不安が高まり，A病院精神科主治医に頻回に電話するようになった．72歳ごろより認知機能障害が明らかとなり，転倒骨折のため入退院を繰り返していた．入院中の異常行動やせん妄および認知機能障害の悪化により73歳時に精神科主治医からの紹介でC病院に転院し，アルツハイマー型認知症の診断を受けた．病棟では幻覚妄想を認めず穏やかに過ごしており，記憶障害，見当識障害が前景に立っていた．

● 現病歴

X−1年6月に右乳房のしこりを自覚し乳がんとの診断を受けた．同年12月に乳がんが乳頭に浸潤し出血，膿汁流出を認めたため，右乳房切除および腋窩リンパ節郭清を目的に当院乳腺外科に紹

表1　MacCAT-T における同意能力の評価基準と質問例

要素	評価基準	評価のための質問例
理解	告知された医学的状態と治療，治療に伴う利点や危険性に関する情報を理解しているか確認するため，本人の言葉で説明するよう促す	「○○先生があなたに説明したこと（疾患名，推奨される治療の説明，治療に伴う利益と危険性，治療を受けない場合の利益と危険性）をどういう病気であるか説明してください」
認識	説明を受けた疾患や医療行為を自分のこととして認識しているか確認するため，医学的状態や提案された治療が自分のためになるか意見を述べるよう求める	「これがあなたの病気の主な特徴ですが，そのことについてなにか疑問に思うことはありませんか」 「この治療を受けることがあなたのためになると思いますか」 「どうしてそう思うのか教えてください」
論理的思考	治療の選択肢と結果を比較し，選択した理由について述べるよう求める．患者は「不合理な」選択をする権利があるため，選択結果ではなく，プロセスに焦点をあてる	「今まで説明したなかで1つ目はAという治療，2つ目はBという治療です．このうちどれを希望しますか」 「(選択した治療）がよいと思うのはどうしてか教えてください」 「(選択した治療）の起こりうる利点と危険性について話してきました．では，この治療があなたの日常生活にどのような影響を及ぼすと思いますか」
選択の表明	患者に治療の選択を示すよう求める	「さきほど（選択した治療）を選ばれていました．一通りのことが話に出ましたが，今はどのように思いますか」

(Grisso T, Appelbaum PS : Assessing Competence to Consent to Treatment ; A Guide for Physicians and Other Health Professionals, Oxford U.P., New York, 1998 ―― 北村總子，北村俊則訳：治療に同意する能力を測定する；医療・看護・介護・福祉のためのガイドライン．日本評論社，東京，2000より．認知症患者用に一部改変）

介された．認知機能障害が顕著であったが，入院には同意したため当院精神科病棟に任意入院となり，乳腺外科との併診となった．

● 入院時所見

1）乳がんの進行度

右乳房に径3cm大の硬結，胸腹部コンピュータ断層撮影（computed tomography；CT）で右腋窩リンパ節腫脹を認めた．乳がんが乳頭に浸潤し腋窩リンパ節転移が疑われるものの，遠隔転移は認めず，臨床的TNM分類はT4N1M0，病期はstage ⅢBと診断された．

2）Neuropsychiatric Inventory-12（NPI-12）

不安（頻度3，重症度1），夜間行動（頻度3，重症度1）．

3）認知機能検査

通常の大きさの声での教示に対する聞き返しや聞き誤りはなく，感覚レベルでの刺激入力に問題はないと判断された．Clinical Dementia Rating（CDR）2，Mini-Mental State Examination-Japanese（MMSE-J）13/30点，Executive Interview（EXIT25）23/50点（失点方式，カットオフ得点：15/16点），ウェクスラー記憶検査改訂版（Wechsler Memory Scale-Revised；WMS-R）の論理的記憶は直後0/50点，遅延0/50点で，記憶障害，前頭葉機能障害，視空間認知障害が顕著に認められた．

4）医療同意能力

手術日前日に改めて本人と家族に対して乳腺外科主治医より手術についての説明があり，精神科主治医，臨床心理士も同席した．その後，本人と家族に対して精神科主治医から再度手術について説明を行い，臨床心理士が本人に対してMacCAT-Tによる同意能力の評価を行った．

MacCAT-Tでは疾患や手術の説明を繰り返し行うことで，「乳がん」「腋の下が腫れている」「マンマの手術」などと平易な言葉で理解できた．しかし，説明を覚えていない点が多く，「今はとくに痛くない」と痛みの自覚も乏しく，「だいぶ前に乳がんは手術したから」と現在の自身の疾患として認識することはできなかった．手術の利点・危険性の理解はきわめて困難で，手術を受けることと手術を受けないことの比較選択はできず，「今は痛くない」とか，長年のかかりつけであったA病院精神科主治医に診てもらっていたと繰り返し述べ，手術に対して消極的な姿勢であった．説明を繰り返すのみでは本人の理解が得られなかったため，①短文や平易な表現での言い換え，②書面での視覚的な提示（注意を向けるところの指さし），③「はい/いいえ」形式の質問を行ったが，同じことを繰り返したり違う話にそれてしまったりと効果は得られなかった．同席した家族がみかねて「手術しないと死んでしまう」と強い口調で説得すると判断が揺れながらも，「でも今は痛くない」と手術に対して明確な同意は得られなかった．このようなやりとりを総合的に判断し，MacCAT-Tは理解0.9/6点，認識0/4点，論理的思考0/8点，選択の表明1/2点と評定した．

ただし，MacCAT-Tとは別に行った精神科主治医の面談時には「先生ががんがあるというのなら取ったほうがよい」と話す場面があり，看護師が処置の際に乳房の病変を一緒に確認した際には，痛みが伴わなくても視覚的に皮膚症状を認識できたりと，時間によって手術に対する同意が変動していた．最終的には，本人と家族双方の同意を得て手術に至った．

5）入院後経過

全身麻酔下での手術であり，錐体外路症状も認めたことから，ハロペリドール6mg，クロルプロマジン225mg，ビペリデン4mg，エチゾラム0.5mgを手術日までに漸減中止し主剤をオランザピン10mgのみとしたが，不眠，せん妄や病的体験は認めなかった．手術日前夜は，手術のことや術前説明を受けたことは忘れていたものの，深夜に不安焦燥が高まり，離床してドアノブを頻繁にいじりながら「戸が開いて鍵が閉まらない」と訴えることがあった．翌日の入院第8日目に右乳房切除および腋窩リンパ節郭清施行．術後翌日，夜間に「部屋の鍵を閉めて」と興奮した以外には目立った興奮や幻覚妄想は認めず，自室に閉居しがちであった．術後経過は良好で，入院第34日目に退院となった．

〈症例2〉56歳，男性

● 診断

軽度知的障害，てんかん

● 生活歴

幼少期の頭部外傷後，意識消失や手足がしびれるような発作が月1〜2回あった．軽度知的障害との診断を受けているが，詳細は不明である．中学校卒業後に就職するものの，てんかん発作のため数年後に休職した．その後，製造業など複数の勤務先を経験したが，31歳時に重度の貧血のためにD病院に入院した．同時期，同居していた伯母が死亡し独居となった．生活費を妹や叔母に借りて生活していたが，借金が増え，44歳ごろには経済的に破綻をきたしていた．高血圧や肺炎，重症貧血で身体科入院歴が複数回ある．45歳ごろより被害妄想や抑うつ気分，意欲低下，自殺念慮などの抑うつ症状が出現し，E病院に任意入院した．その後も高血糖や右肩骨折手術，てんかん，肺炎で入退院を繰り返していたが，精神状態はおおむね安定していた．

● 現病歴

X−1年より，ふらつき，被害妄想や易怒性，粗暴行為が出現し，薬剤調整が困難な状態であった．X年7月より歩行障害や失禁が目立つようになり，F病院において頭部CTにより正常圧水頭症と指摘され，診断目的で入院したもののタップテストの施行ができず退院となった．徐々に精神状態は安定し，X年11月に当院脳神経外科に紹介され，正常圧水頭症の診断と治療を目的に当院精神科病棟に任意入院となった．

● 入院時所見

1）NPI-12

妄想（頻度1，重症度1），興奮（頻度2，重症度1），易刺激性（頻度2，重症度1），睡眠（頻度4，重症度1）．

— 191 —

2）認知機能検査

評価時には通常の大きさの声で行っても聞き返しや聞き間違いはなく，聴覚障害による影響はうかがえなかった．タップテスト前は不機嫌で検査に対して拒否的で，何度か促しても無反応であることが多かったが，タップテスト後は穏やかで協力的な反応が得られ，時折，注意が途切れて無反応になるものの促しにより応答するようになった．タップテスト前のMMSE-Jは13/30点であったが，タップテスト後はMMSE-J 21/30点となり，CDRは1，EXIT25は18/50点（失点方式，カットオフ得点：15/16点），WMS-R論理的記憶は直後2/50点，遅延2/50点で，記憶障害および前頭葉機能障害がうかがえるものの，認知機能の改善がみられた．

3）医療同意能力

タップテスト後，認知機能と精神状態が安定した際に同意能力を評価した．精神科主治医から手術について説明をし，その後，臨床心理士がMacCAT-Tを施行した．認知機能検査の施行でもみられたように時々無反応になることはあったものの，説明を繰り返したり追加の質問を行って具体的に促したりすると回答が得られた．正常圧水頭症の診断名，「歩きにくい」や「おしっこが漏れる」などの症状，「頭からお腹に液を流す」といった治療の簡単な説明はでき，自身の病気として認識していた．「歩行がよくなる」といった手術の利点は平易な表現で説明することができ，手術による感染症や出血の危険性については，「はい/いいえ」の2択で問うと正しく答えることができた．MacCAT-Tでは理解4.55/6点，認識3/4点，論理的思考6/8点，選択の表明2/2点と評価された．

4）入院後経過

入院第6日目にタップテストを施行し，認知機能障害や歩行障害の改善を認め，脳室-腹腔シャント（ventriculo-peritoneal; VP shunt，V-Pシャント）留置術適応と判断された．入院第15日目に脳神経外科主治医から本人と家族に手術に関する説明が行われ，本人と家族の同意を得て，入院第21日目にV-Pシャント留置術施行．術後も精神状態の変動なく経過し，認知機能と歩行障害の改善を認めた．一時的に気分は変動し，気にいらないことがあると医療者を無視したり拒食することがあったが，易怒的，衝動的とはならず精神状態はおおむね落ち着いていた．術後経過は良好で，入院第42日目に退院となった．

Ⅲ．考　察

認知機能が低下した高齢者に対して医療行為が必要な場合，同意能力の判定がしばしば問題となる．しかし，従来は明確な手続きを踏まずに各医師の判断によって対応されていることが多く，医療行為の侵襲性が高くリスクがある場合や，患者が医師の提案に同意しないときにのみ同意能力が問題とされるといった点が指摘されてきた[6]．最近では，身寄りがない精神障害者や治療選択がむずかしく本人の意思確認が困難な症例に対して，院内の倫理委員会に諮問して判断を仰ぐ場合も報告されているが[7,10]，いかに同意能力の評価が行われ医療行為の実施に至ったか明確な評価ツールや一定のプロセスは確立していないのが現状である[14]．

今回，筆者らは身体疾患の医療行為を受ける必要がある認知機能が低下した患者に医療同意能力の評価を行った2症例を報告した．これらの症例をとおして，認知症高齢者の医療同意にまつわる問題点や今後の課題について考察を加えたい．

今回呈示した2症例は認知機能障害が存在するものの，入院が必要なことはある程度理解しており，入院に積極的な拒否を示さなかったため任意入院となった．しかし，医療行為への同意となるとより難易度が高く，主治医の見解では，いずれも医療行為の利点や危険性，日常生活への影響などを推測して論理的に判断して手術に同意することは難しいと予想されていた．

実際にMacCAT-Tを用いて同意能力を評価したところ，症例1は疾患名や手術の説明に対してごく簡単な理解を示すことはできたが，疾患を自分のこととして認識したり，論理的な思考によって判断したりすることはできず，主治医の見解と同様に，治療に関して判断能力や同意能力は不十分であると考えられた．一方，症例2は疾患や医療行為への理解を示し，自分の疾患としての認識も有しており，手術の利点や危険性について把握したうえで治療に同意していることが確認された．すなわち，主治医の見解では同意能力はないと考えられていたが，MacCAT-Tによる評価では同意能力を有していることが判明したのである．

同意能力の評価として重要な点は，本人の自己決定に基づく医療を実践するため，判断能力がある患者の意思は尊重し，判断能力が減弱，欠如している患者については本人をサポートする手だてを講ずることにある[3]．今回，MacCAT-Tによって同意能力の評価を行った意義としては，以下の点が挙げられよう．

まず，症例2は同意能力の評価を行わなければ通常では同意能力がないと判断されてしまう可能性が高かった．客観的な評価ツールを用いることで，このような認知機能障害がある患者に対しても患者本人の自己決定に基づく医療行為の実践が可能になると考えられる．たとえ認知機能検査の結果がよくなかったとしても同意能力が保たれていることもあり[12]，認知症だからといって同意能力がないと等しく考えることはできない．たとえば，予防注射と胃瘻に求められる同意能力の水準が異なるように，それぞれの臨床場面ごとに必要とされる同意能力の程度は異なり，一概に「あり/なし」で決められるものではない．同意能力には認知機能レベル，医療行為の選択肢の複雑さ，痛みなどの自覚症状の程度，精神症状など多様な要素が関連してくるものであり，それぞれの要素を丁寧に評価していくことが求められる．

また，症例1は主治医の見解と同様にMacCAT-Tによっても同意能力がないと判断された症例である．この場合，単に同意能力がないという見解のもと，本人ではなく代諾者である家族に同意を求めるのではなく，理解を促す手段を講じたうえで医療従事者と患者本人が医療行為についてしっかりと向き合って話す時間を設定できたという点が重要であったと思われる．さらに，MacCAT-Tによる評価ツールをきっかけとして，看護師が処置の際に乳房の病変を一緒に確認しながら疾患の説明を行うと同意を示す言動が認められたという点にも着目することができ，視覚を活用するなど残存する感覚認知を最大限に活用することにより同意を得られる可能性があることが示唆された．同意能力は，理解・判断・記憶のプロセスから成立する．MacCAT-Tを中心に複数の認知機能検査を組み合わせることで，同意能力の有無を判断するにとどまらず，いかに同意能力をサポートするかの糸口を見いだすことにつながると思われる．

これらの意義とともに，同意能力評価を行ううえでいくつか検討するべき課題もある．

第1に，症例1は認知機能障害による判断力の低下が顕著で，痛みの自覚も伴わなかったため，医療行為への理解を得ることに難渋した．また，確認する時間帯によって医療行為への同意も変動しており，本人の真の意思をどうとらえるか考えさせられた．一般的に，同意能力は時間的に変動し状況にも左右されやすいものであることから[3]，一度きりの評価や一つの場面で評価するのではなく，コミュニケーションを繰り返し図るなかで判断することが推奨される[4]．ただし，繰り返し評価するだけではなく，同意能力の評価にどれほどの時間をかけられるか，医療行為を要する疾患の緊急性や重大性なども踏まえて最適な回数を検討しなければならない．実際には3回実施するなかでどの回答が多くみられるかといった方法が現実的であろうが，評価者も1人に限定することなく，複数の医療従事者が評価することで，より客観的となり信頼性が高まると考えられる．また，不十分な説明はいうまでもなく問題であるが，詳しく説明を行おうと説明を度重ねて行うことで患者の不安を増幅したり，精神症状を悪化させたりする可能性にも注意をはらう必要がある[13]．症例1でも手術の説明を受けたことは覚えていなかったが，手術前夜に一時的に不安焦燥が高まっていた．医療者側の情報提供をどのような方法でどこまで行

うのかをも検討すべきである．

第2に，上述したように同意能力の評価を行ううえでは，患者が最良の回答を行えるよう本人の保たれているコミュニケーション機能を活用し，状態に応じた意思疎通を図ることが重要となる[5]．たとえば，症例2のように，専門的な用語を避け，説明を短く区切ることで理解力の成績が向上する場合がある[19]．選択肢を狭めて必要な同意能力の水準を下げるのも一つの方法である．さらに，図や模型，ビデオなどのツールの使用，「はい/いいえ」による応答を繰り返して意思を確認する手法などが報告されている[5,12]．これらのサポート方法を効果的に提示するにはどうしたらよいか，多職種間でノウハウを蓄積し，医療従事者が利用しやすいかたちにまとめたマニュアルがあれば，現在の医療現場における一つの指針となると考えられる．

最後に，今回の2症例ともに同意能力の結果について精神科と身体科で十分に協議することが困難であった．今日，一般の身体科においても真に患者の自己決定に基づく医療を実践するためには，同意能力の評価が果たす役割は大きい[8]．精神科医療にとどまらず，積極的に多職種によるカンファレンスの開催などをとおして連携，協議していくことが重要である．かつ，多忙な診療のなかでも長時間要することなく簡便に行うことのできる客観的な評価ツールが求められている．同意能力判定には，MacCAT-Tのような面接法を用いた同意能力に特化した検査を行う価値は高いと思われるが，従来のMMSEや他の認知機能検査から同意能力を推定することはできるのか，また，どの検査が有用なのかについても検討していく必要がある．

今回の試みをはじめとして，現在，筆者らは認知症高齢者の同意能力に関する意識を向上し，社会全体の問題として一定のコンセンサスが得られるよう，現場で運用可能な判定ツールを作成中である．超高齢社会日本における同意能力の問題に対して一つの指針となり，より円滑な医療行為の実施や高齢者本人の意思を反映させた医療が行われることが期待される．

結　語

認知機能が低下した患者に医療同意能力の評価を行った症例報告を行い，同意能力にまつわる問題点や同意能力評価の課題について考察した．今後はさらに同意能力評価を行う症例を蓄積し，現場で運用可能な評価ツールを構築していきたいと考えている．

本稿の要旨は第28回日本老年精神医学会（大阪府大阪市，2013年）にて発表した．

本研究は公益社団法人日本老年精神医学会の利益相反委員会の承認を受けた．

文　献

1) 明智龍男：厚生労働科学研究費補助金（がん臨床研究事業）総括研究報告書「高齢がん患者の治療開始および中止における意思決定能力の評価およびその支援に関する研究」．(2010)．
2) Grisso T, Appelbaum PS, Hill-Fotouhi C : The MacCAT-T ; A clinical tool to assess patients' capacities to make treatment decisions. *Psychiatr Serv*, 48 (11) : 1415-1419 (1997).
3) Grisso T, Appelbaum PS : Assessing Competence to Consent to Treatment ; A Guide for Physicians and Other Health Professionals. Oxford U.P., New York (1998). (北村總子，北村俊則訳：治療に同意する能力を測定する；医療・看護・介護・福祉のためのガイドライン．日本評論社，東京，2000)
4) 広田伊蘇夫：精神医療における倫理的ジレンマ．精神医学，35 (8) ; 891-894 (1993)．
5) 飯干紀代子：今日から実践　認知症の人とのコミュニケーション；感情と行動を理解するためのアプローチ．中央法規出版，東京 (2011)．
6) Jourdan JB, Glickman L : Reasons for requests for evaluation of competency in a municipal general hospital. *Psychosomatics*, 32 (4) : 413-416 (1991).
7) 北村　立：認知症患者の医療行為における治療選択と同意について．臨床精神薬理，15 (11) : 1785-1792 (2012)．
8) 北村俊則，北村總子：精神科医療・研究における判断能力評価の意義と実践．臨床精神薬理，15 (11) : 1751-1757 (2012)．

9) Lui VW, Lam LC, Luk DN, Wong LH, et al.: Capacity to make treatment decisions in Chinese older persons with very mild dementia and mild Alzheimer disease. *Am J Geriatr Psychiatry*, 17 (5) : 428-436 (2009).
10) 松井徳造，松永寿人，志田尾敦，矢守康文：白内障手術を要した痴呆患者の同意能力とインフォームド・コンセントについて．臨床精神医学，29 (7) : 745-751 (2000)．
11) Maxmin K, Cooper C, Potter L, Livingston G : Mental capacity to consent to treatment and admission decisions in older adult psychiatric inpatients. *Int J Geriatr Psychiatry*, 24 (12) : 1367-1375 (2009).
12) 箕岡真子：バイオエシックスの視点よりみた認知症高齢者の医療における「自己決定」と「代理判断」．(新井　誠編) 成年後見と医療行為，159-186，日本評論社，東京 (2007)．
13) 成本　迅：科学技術振興機構　社会技術研究開発事業　高齢社会に関する新しい研究開発領域研究課題提案に係る深掘り調査報告書「認知症患者の権利擁護のための意思決定能力判定システムの開発」．(2009)．
14) 白石弘巳：医療における高齢者の同意能力．老年精神医学雑誌，13 (10) : 1121-1126 (2002)．
15) 寺脇博之，佐藤壽伸，三浦伸義，斎藤恵子ほか：慢性腎臓病（CKD）ステージ5患者の治療同意能力に関する予備的検討．日本腎臓学会誌，50 (7) : 915-926 (2008)．
16) 筑波大学附属病院精神神経科：総合研究報告書「都市部における認知症有病率と認知症の生活機能障害への対応」．(2013)．http://www.tsukuba-psychiatry.com/?page_id=806 (2013年6月14日閲覧)．
17) Turrell SL, Peterson-Badali M, Katzman DK : Consent to treatment in adolescents with anorexia nervosa. *Int J Eat Disord*, 44 (8) : 703-707 (2011).
18) 内田信之，塩島正之，笹本　鑑，山本英輝ほか：精神分裂病合併乳癌患者の臨床的問題；2症例の経験から．乳癌の臨床，16 (3) : 306-309 (2001)．
19) Wong JG, Clare ICH, Holland AJ, Watson PC, et al.: The capacity of people with a 'mental disability' to make a health care decision. *Psychol Med*, 30 (2) : 295-306 (2000).

Assessment of health care decision-making capacity in patients with cognitive impairment

—— Use of the MacArthur Competence Assessment Tool-Treatment ——

Yuka Kato[*1,8], Teruyuki Matsuoka[*1,8], Mayu Ogawa[*1,8], Shogo Taniguchi[*1,8], Hiroshi Fujimoto[*1,8], Mie Urabe[*2,8], Keisuke Shibata[*3], Kaeko Nakamura[*1], Yoko Eguchi[*4,8], Kiyoko Iiboshi[*5,8], Hiroyuki Koumi[*6,8], Shutaro Nakaaki[*7,8], Masaru Mimura[*7,8], Kenji Fukui[*1], Jin Narumoto[*1,8]

* 1 *Department of Psychiatry, Graduate School of Medical Science, Kyoto Prefectural University of Medicine*

* 2 *Department of Nursing, Graduate School of Medical Science, Kyoto Prefectural University of Medicine*

* 3 *Kawagoe Hospital*

* 4 *National Institute of Radiological Sciences*

* 5 *Department of Clinical Psychology, Shigakukan University*

* 6 *Department of Clinical Psychology, Faculty of Social Welfare, Hanazono University*

* 7 *Department of Neuropsychiatry, Keio University School of Medicine*

* 8 *RISTEX, JST*

Objectives : We report two case studies of older patients who needed to be assessed for their capacity to consent to medical treatment by MacArthur Competence Assessment Tool-Treatment (MacCAT-T).

Case 1 : An 80-year-old woman with dementia who suffered from recurrence of cancer in the right breast was hospitalized to undergo medical treatment. Her cognitive functions were severely disturbed. She did not report any pain and her decision fluctuated with time. MacCAT-T revealed that she could not understand the necessity of the treatment and her capacity was insufficient. Eventually, her sister persuaded her to undergo the operation.

Case 2 : A 56-year-old man with normal pressure hydrocephalus was recommended to undergo ventriculoperitoneal shunt. Mild disturbance of cognitive functions were observed. By giving simple and easy to understand explanations, he was able to understand the benefits of the operation and gave consent consistently. MacCAT-T revealed that his capacity was sufficient.

Conclusion : When evaluating capacity among older people with cognitive impairments, we need to consider their cognitive function, neuropsychiatric symptoms, the complexity of the choices of treatment, and the degree of subjective symptoms of pain. Also, it is important to evaluate their capacity repeatedly, considering the fluctuation of psychiatric symptoms and cognition.

Key words : dementia, older patient, decision-making capacity, cognitive testing, MacArthur Competence Assessment Tool-Treatment

Brain and Cognition 84 (2014) 63–68

Contents lists available at ScienceDirect

Brain and Cognition

journal homepage: www.elsevier.com/locate/b&c

Decision-making deficit of a patient with axonal damage after traumatic brain injury

Fumihiko Yasuno [a,*], Kiwamu Matsuoka [a], Soichiro Kitamura [a], Kuniaki Kiuchi [a], Jun Kosaka [a], Koji Okada [a], Syohei Tanaka [a], Takayuki Shinkai [b], Toshiaki Taoka [c], Toshifumi Kishimoto [a]

[a] *Department of Psychiatry, Nara Medical University, Kashihara, Japan*
[b] *Department of Radiation Oncology, Nara Medical University, Kashihara, Japan*
[c] *Department of Radiology, Nara Medical University, Kashihara, Japan*

ARTICLE INFO

Article history:
Accepted 13 November 2013
Available online 5 December 2013

Keywords:
Traumatic Brain Injury (TBI)
Decision-maiking process
Somatic-marker hypothesis
Diffusion tensor imaging (DTI)
Voxel-based morphometry (VBM)

ABSTRACT

Patients with traumatic brain injury (TBI) were reported to have difficulty making advantageous decisions, but the underlying deficits of the network of brain areas involved in this process were not directly examined. We report a patient with TBI who demonstrated problematic behavior in situations of risk and complexity after cerebral injury from a traffic accident. The Iowa gambling task (IGT) was used to reveal his deficits in the decision-making process. To examine underlying deficits of the network of brain areas, we examined T1-weighted structural MRI, diffusion tensor imaging (DTI) and Tc-ECD SPECT in this patient. The patient showed abnormality in IGT. DTI-MRI results showed a significant decrease in fractional anisotropy (FA) in the fasciculus between the brain stem and cortical regions via the thalamus. He showed significant decrease in gray matter volumes in the bilateral insular cortex, hypothalamus, and posterior cingulate cortex, possibly reflecting Wallerian degeneration secondary to the fasciculus abnormalities. SPECT showed significant blood flow decrease in the broad cortical areas including the ventromedial prefrontal cortex (VM). Our study showed that the patient had dysfunctional decision-making process. Microstructural abnormality in the fasciculus, likely from the traffic accident, caused reduced afferent feedback to the brain, resulting in less efficient decision-making. Our findings support the somatic-marker hypothesis (SMH), where somatic feedback to the brain influences the decision-making process.

1. Introduction

Traumatic brain injury (TBI) is a major public health problem. Although medical disabilities usually stabilize after onset, neuropsychological consequences can cause chronic handicaps that often do not receive appropriate attention and treatment (Dombovy & Olek, 1997). In particular, they show significant deficits in tasks relying on focused and divided attention (Stuss et al., 1989), on verbal memory (Crosson, Novack, Trenerry, & Craig, 1988) and on executive functions (Stuss & Gow, 1992). Executive impairments are related to planning, inhibitory control, monitoring, and mental flexibility.

Patients with TBI also have difficulties in making deliberate and advantageous decisions (Levine et al., 2005; Santoro & Spiers, 1994; Yody et al., 2000). As, after TBI, patients are often confronted with a completely new and difficult living situation, important decisions have to be made by them and their relatives. Spontaneous wrong decisions may have disastrous long-lasting consequences, such as unemployment, alienation from family and friends and legal problems, which are often linked to the disability to make adequate and advantageous choices (Warriner & Velikonja, 2006).

Damasio has proposed an influential model of human decision-making – the somatic-marker hypothesis (SMH), where he argues that somatic feedback to the brain influences decision-making in man (Damasio, 1994). It is proposed that when choosing between options that differ in relative risk, a somatic marker (e.g. a 'gut feeling') feeds back to the brain and influences decision-making. In line with this hypothesis, the reduced afferent feedback of a somatic marker to the brain would result in abnormal decision-making.

In the present study we report a patient with TBI who demonstrated problematic behaviors in situations of risk and complexity after cerebral injury due to a traffic accident. The Iowa gambling task (IGT) was used to test and confirm his deficits of the decision-making process (Bechara, Damasio, Damasio, & Anderson, 1994). To examine underlying deficits of the network of brain areas involved in his decision-making process, we compared the diffusion tensor and gray matter images of MRI between the patient and healthy control subjects. We expected that the patient would show microstructural abnormality in the fasciculus as a result of

* Corresponding author. Address: Department of Psychiatry, Nara Medical University, 840 Shijocho, Kashihara, Nara 634-8522, Japan. Fax: +81 744 22 3854.
E-mail address: ejm86rp@yahoo.co.jp (F. Yasuno).

0278-2626/$ - see front matter © 2013 Elsevier Inc. All rights reserved.
http://dx.doi.org/10.1016/j.bandc.2013.11.005

the traffic accident, causing reduced afferent feedback to the brain that would lead to less efficient decision-making.

2. Methods

2.1. Case report

The patient was a 30-year-old right-handed man. He had no history of alcohol or illicit drug abuse. His parents reported no family history of any major mental illness. His early childhood development was reportedly unremarkable. Before the accident, he had no significant medical problems or past psychiatric history. His personality before the accident was described by his homeroom teacher at high-school as humorous, popular, and cooperative.

At the age of 17, the patient sustained a TBI in a motorcycle accident. He was transported to a local hospital. There is no record of the Glasgow Coma Scale score, but his family reported that he fell into a coma for 6 h. The initial CT scans of the head revealed no particular change. After awakening, he was discharged to his home. According to the family, after the accident, he began to show outbursts of anger and physically aggressive behavior. He came to act recklessly and unexpectedly. He repeatedly changed his job at short intervals. He was deeply in debt and often had girl troubles.

To investigate whether traumatic brain dysfunction existed and was related to the problematic behaviors, he was referred to the outpatient psychiatry unit at our hospital for judicial psychiatric evidence. A physical examination revealed no abnormalities. He was alert, attentive and oriented. Spontaneous speech, comprehension, repetition, and naming were normal, as were calculation, mapping, praxis, right-left orientation, and finger naming. He did not have a history or present diagnosis of any axis I disorders of Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) or any neurological illness. Electroencephalography showed no relevant abnormalities.

2.2. Neuropsychological evaluation

2.2.1. General cognitive testing (see Table 1)

A more extensive neuropsychological evaluation was performed. The patient was alert, attentive, socially appropriate, and had normal digit span performances, seven digits forward and four backward.

Intellectual functioning as assessed by Wechsler Adult Intelligence Scale-III (WAIS-III) (Wechsler, 1981) and Raven's Coloured Progressive Matrices (RCPM) (Raven, 1958) was adequate. Word fluency (Borkowski, Benton, & Spreen, 1967) was normal, and all language and language-related functions were intact. The patient had no memory deficits. Results with the Rey Auditory Verbal Learning Test-Revised (RAVLT-R) (Spreen & Strauss, 1991) and performance on the Wechsler Memory Scale-Revised (WMS-R) (Wechsler, 1987) were also excellent.

In the assessment of frontal function, the results of Frontal Assessment Battery (FAB) (Dubois, Slachevsky, Litvan, & Pillon, 2000), Wisconsin Card Sorting Test (WCST) (Berg, 1948), and Stroop test (Stroop, 1935) were normal. The Behavioral Assessment of Dysexecutive Syndrome (BADS) (Wilson, Alderman, Burgess, Emslie, & Evans, 1996) showed excellent scores. The total scores of the Dysexecutive Questionnaire (DEX) rated by the patient and his family were within normal range. However, his family rated high scores in the questionnaire of impulsiveness and aggressiveness.

2.2.2. Iowa gambling task (Bechara et al., 1994)

From the patient's reports of problematic behavior after the motorcycle accident, we suspected that he had difficulty with the decision-making process due to his TBI. IGT was used to test his ability of decision-making. It consists of a computerized card game where the player is instructed to try to win as much money as possible with 100 selections from any one of four decks. The rules are not disclosed, and the player gradually learns that two of the decks are 'high risk' (A and B), i.e., intermittently produce large rewards but in the long term lead to significant financial losses, whereas two decks (C and D) lead to modest but consistent gains. Healthy individuals have previously been shown to learn to avoid the risky decks, whereas patients with decision-making difficulty process select an excessive number from the risky decks, and consequently lose money. Data analysis examined the quality of the decision-making as measured by the net score [choice of advantageous decks (C and D) – disadvantageous decks (A and B)] across five 20-trial blocks. The patient's result was compared to those of healthy male controls ($n = 12$, age: 31.9 ± 10.5).

Table 1
Neuropsychological test results.

	Patient's scores
General intelligence	
MMSE	30/30
RCPM	35/36
WAIS-R (vIQ, pIQ, fIQ)	91, 90, 89
Memory	
RAVLT-R	
Trials 1–5	7, 11, 14, 14, 14
Post-interference	13
Delayed recognition	13
WMS-R (Index)	
General memory index	101
Verbal memory index	95
Visual memory index	116
Attention/concentration	97
Delayed index	104
Frontal function	
Trail making A	25 s
Trail making B	70 s
Frontal assessment battery (FAB)	17/18
WCST (category achieved)	6
Stroop test: word, color, word-color	98, 82, 59
BADS (index)	118
DEX (self-version, family-version)	19, 18

MMSE = mini-mental state examination; RCPM = Raven's colored progressive matrices; WAIS-R = Wechsler adult intelligence scale revised; RAVLT-R = Rey auditory verbal learning test revise; WMS-R = Wechsler memory scale revised; WCST = Wisconsin card sorting test; BADS = Behavioral Assessment of Dysexecutive Syndrome; DEX = Dysexecutive Questionnaire.

2.3. Data acquisition of MRI

All MRI examinations were performed by 3.0-T scanner (Magnetom Verio, Siemens AG, Erlangen, Germany). DT images were acquired with echo-planar imaging (EPI) sequence (TR = 14,000 ms, TE = 84 ms, $b = 1000\ s/mm^2$, FOV = 256 mm, matrix = 128 × 128, slice spacing = 2 mm, slice thickness = 2 mm, averaging = 3). The reconstruction matrix was 256 × 256 matrix by interpolation, and 2 mm × 2 mm × 2 mm voxel data were obtained. Motion probing gradient (MPG) was applied in 12 directions. High-resolution three-dimensional T1-weighted images were acquired using a magnetization prepared rapid gradient echo (MPRAGE) sequence (TR = 1800 ms, TE = 2.4 ms, TI = 800 ms, flip angle = 10°, FOV × 256 mm, slice thickness = 1 mm; 208 sections in the sagittal plane; acquisition matrix, 256 × 256; acquired resolution, 1 × 1 × 1 mm). The patient's result was compared to those of healthy controls ($n = 13$, 7 males and 6 females, age: 30.0 ± 9.5).

2.4. Imaging processing of MRI

Fractional anisotropy (FA) maps were generated from each individual using "dTV II" software (Masutani, Aoki, Abe, Hayashi,

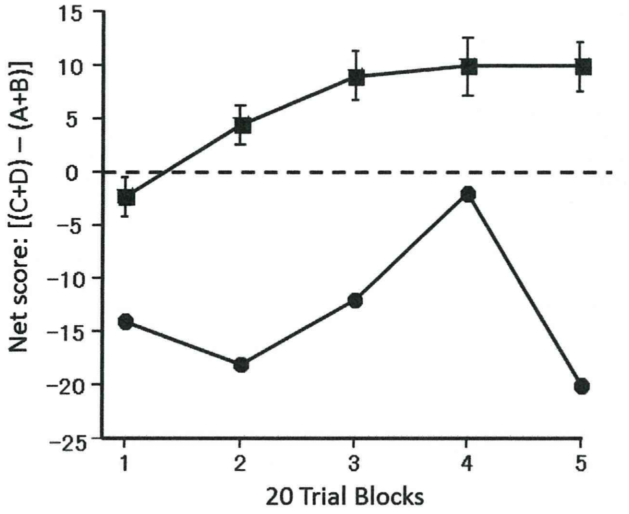

Fig. 1. Decision-making performance on the Iowa gambling task (IGT) of the patient (circles) and control subjects (squares). The figures shows the net score (choice of advantageous decks–disadvantageous decks) across 100 test trials, divided into five 20-trial blocks.

& Otomo, 2003). Image preprocessing and statistical analysis were carried out using SPM8 (Wellcome Department of Imaging Neuroscience, London, England). Each subject's image was spatially normalized to the Montreal Neurological Institute image template using parameters determined from the normalization of the image with a b value of 0 s/mm^2 and the echo planar image template in SPM8. Images were resampled with a final voxel size of 2 × 2 × 2 mm^3. Normalized gray matter image maps were generated from each individual using the VBM8 toolbox with SPM8 software. Normalized maps were spatially smoothed using an isotropic Gaussian filter (8-mm full-width at half-maximum). Normalized and smoothed FA and gray matter image maps were compared with voxel-based analysis between the patient and healthy controls with Jack-knife analysis. Statistical inferences were made with a voxel-level threshold of $p < 0.001$, uncorrected, with a minimum cluster size of 50 voxels.

2.5. Data acquisition and analysis of SPECT

Tc-ECD SPECT studies were performed using a dual-headed γ-camera (TOSHIBA SYMBIA E, Toshiba, Japan). Tc-ECD SPECT imaging with a fan-beam collimator was started 10 min after an intravenous bolus injection of 600 MBq Tc-99 m ECD. Tomographic data with a slice thickness of 5.39 mm were obtained continuously for 24 min. Static data were acquired in 128 × 128 matrices. The data were prefiltered using a Ramp filter with a high cut-off value. Stereotactic statistical imaging analysis of the brain using the easy *Z*-score imaging system was performed, and decrease in regional cerebral blood flow of the patient was investigated (Mizumura & Kumita, 2006).

3. Results

The patient produced normal performance on a variety of neuropsychological tests (Table 1), but showed abnormality in IGT. As shown in Fig. 1, beginning at approximately the 20th trial, control subjects shifted their preference toward advantageous decks, whereas the patient preferred disadvantageous decks and his net scores were less than zero over the 100 trials.

DTI-MRI results showed that the patient had a significant decrease of FA. As shown in Fig. 2 and Table 2, the patient had

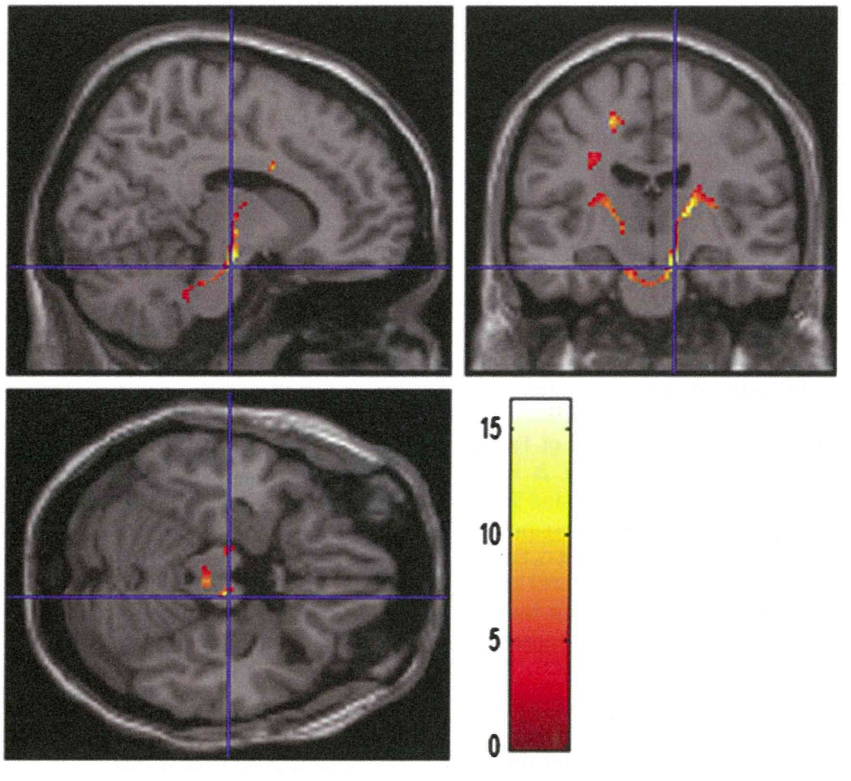

Fig. 2. Significant decrease of regional FA values in the patient when compared to healthy controls. Detected areas exceed uncorrected p value of 0.001 with 50 or more contiguous voxels. These statistical parametric mapping projections were then superimposed on representative transaxial ($z = -23$), sagittal ($x = 12$), and coronal ($y = -14$) magnetic resonance images.