region-specific biological effect of the e4 allele, provided that in AD patients there is an association of ApoE ε4+ with atrophy (Juottonen *et al.*, 1998; Geroldi *et al.*, 1999), and a reduction of cerebral glucose metabolism (Hirono *et al.*, 2002) in the medial temporal lobe, a region where olfactory and cognitive processing are considered to take place. The observed difference of correlation between cognitive performance and olfactory identification depending on ApoE genotype in AD patients may endorse phenotypic heterogeneity of the disease. Stronger correlation in patients with the ε4 allele suggests higher involvement of medial temporal lobe dysfunction in the phenotypic subgroup relative to patients without the ε4 allele. However, considering a significant age difference between the two phenotypic groups, patients without the ε4 allele, who were older than those with the ε4 allele, were more likely to be affected by accompanying cerebrovascular lesions, which may have confounded the results in assessing the correlation between the P-SIT scores and the MMSE scores (Gray *et al.*, 2001).

In conclusion, this study confirmed that the non-lexical test of olfactory identification discriminates AD patients from non-demented elderly subjects with high sensitivity and specificity. Also, the impairment of olfactory identification correlates well with the degree of cognitive decline in AD patients. The correlation is more pronounced in AD patients who carry ε4 allele. We therefore propose a short and simple olfactory test appropriate for clinical use in Japanese elderly population to improve diagnostic accuracy in patients with AD.

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Prevention of Late Complications by Half-Solid Enteral Nutrients in Percutaneous Endoscopic Gastrostomy Tube Feeding

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Key Words
Percutaneous endoscopic gastrostomy · Enteral nutrients, half-solid · Gastroesophageal reflux

Abstract
Background: Percutaneous endoscopic gastrostomy feeding is accompanied by unique complications, which are not easily controlled. ***Objective:*** In an attempt to decrease complications, we used half-solid nutrients for percutaneous endoscopic gastrostomy feeding in an 85-year-old woman. The patient had been receiving enteral nutrients via percutaneous endoscopic gastrostomy, and we examined whether this approach can reduce complications. She presented with regurgitation of enteral nutrients and recurrent respiratory infections. ***Methods:*** Half-solid enteral nutrients, prepared by mixing liquid enteral nutrients with agar powder, were administered via percutaneous endoscopic gastrostomy. ***Results:*** Symptoms of gastroesophageal reflux disappeared immediately after the start of half-solid enteral nutrient feeding. ***Conclusion:*** Gastroesophageal reflux and leakage, two intractable late complications of percutaneous endoscopic gastrostomy tube feeding, can be alleviated by the solidification of enteral nutrients. Since this method allows quick administration of nutrients, it is also expected to help prevent the occurrence of decubitus ulcers and reduce the burden to the caregiver.

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Introduction

Feeding via a percutaneous endoscopic gastrostomy (PEG) tube is a safe and efficient method for patients who cannot maintain adequate oral intake. PEG feeding is accompanied, however, by unique complications which are not easily controlled. The administration of liquid nutrients is often accompanied by complications such as vomiting and diarrhea, although these complications may be minimized if the patient is sitting up during the administration or if the nutrients are administered at a slower rate. Nevertheless, these methods do not completely succeed in eliminating these common complications, and may require the patients and their caregivers to have great patience. In addition, maintaining the same position for many hours may worsen the conditions of patients who have pressure ulcers. Here we report a case in which, by

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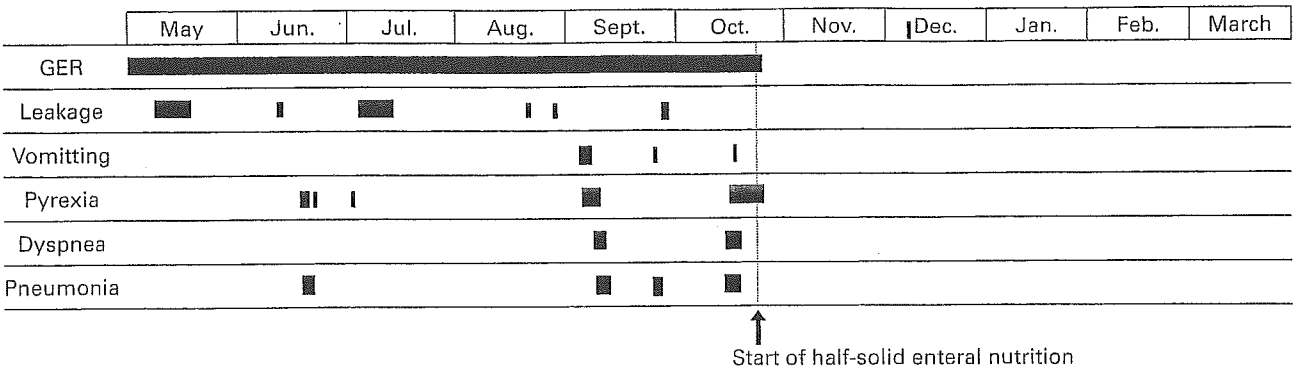

Fig. 1. Reduction of symptoms after half-solid enteral nutrition via PEG.

simply solidifying nutrients, the symptoms due to gastroesophageal reflux (GER) after PEG tube placement were relieved, and the leakage of nutrients from the PEG tube insertion site was alleviated.

Methods

An 85-year-old woman presented with regurgitation of enteral nutrients and recurrent respiratory infections after PEG placement. The patient suffered a cerebral infarction, and underwent PEG insertion on May 4, 2001, at a local hospital. After commencing PEG tube feeding, the following symptoms repeatedly occurred: regurgitation of the enteral feed; leakage of nutrients from the PEG tube insertion site; vomiting followed by pyrexia; dyspnea during the administration of nutrients, and pneumonia confirmed by chest X-ray. The patient often showed facial signs of discomfort during the feed administration. Liquid enteral nutrients were given in a sitting position at all times.

As the complications gradually became more frequent in occurrence, on October 21, 2001, we commenced giving her half-solid enteral nutrients which were prepared by mixing market-available enteral nutrients and agar powder. Half-solid nutrients were prepared by mixing 5 g agar powder with 500 ml liquid nutrients diluted with the same volume of water (1,000 ml total volume). The mixture was distributed into 50-ml syringes and kept in a refrigerator until it was administered via the PEG tubing. The mixture was not liquefied in the stomach due to body temperature. The administration of half-solid nutrients was made by injecting them into the stomach en bloc (injection time <5 min). The patient was not forced to remain in a sitting position during and after the administration.

Results

The symptoms, other than pyrexia, disappeared immediately after the administration of half-solid nutrients, and pyrexia vanished 2 weeks later. Also, the signs of discomfort during the feed administration were no longer noted. We followed the patient for up to 6 months after the start of the half-solid enteral nutrients, and observed no recurrence of the symptoms (fig. 1). At present (February 2004), the patient still remains in a stable condition and no longer suffers from the complications observed before the commencement of half-solid nutrients.

Discussion

PEG feeding is accompanied by unique complications, which occur over a long-term clinical course [1–3]. An increase in vomiting is one of the most common complications [4]. GER is clinically manifested by recurrent vomiting or aspiration. The mechanism by which GER increases in frequency has not yet been clarified.

Ogawa et al. [5, 6] suggested that since the stomach cannot move independent of the abdominal wall after the formation of a gastric fistula, enteral nutrients remain in the stomach longer, thereby increasing the chance of GER. Gastrin, a potent facilitator of peristaltic movement, may not be sufficiently induced by the distension of the stomach seen with slow infusion rates of liquid nutrients. Thus enhanced GER may eventually result. Since the nutrients can be administered in a short time by

our method (<5 min), the stomach wall is expected to be distended to a greater degree and thus stimulate peristaltic movement.

Another disadvantage of slow feed infusion is that patients are forced to remain in a sitting position for long periods while the nutrients are administered, which is unfavorable in terms of the prevention of decubitus ulcers, which are commonly found in patients with PEG feeding.

One of the late complications after PEG tube placement is leakage from the PEG tube insertion site. This is a difficult problem to cope with. There are two causes of leakage: inappropriate fixation of the bumper (including the so-called buried bumper syndrome [7]), and a decrease in the elasticity of the fistular opening, which develops over a long period after PEG placement [8]. The leakage resulting from a decrease in elasticity is intractable. Simply increasing the tube diameter cannot solve this problem [7, 9]. We found, however, that solidification of the enteral nutrients alleviated the leakage in the present case. This may simply be explained by the fact that the solidified nutrients could not be leaked out by the intragastric pressure through the narrow gap between the fistular pore and the tube.

So far, we have administered half-solid nutrients to 17 patients with PEG feeding and followed up the patients for 6 months. During the observation period, we confirmed significant reductions in the complications observed before the commencement of the half-solid nutrients (data not shown).

In conclusion, our experience indicates that the use of half-solid nutrients in PEG feeding and their rapid administration can substantially reduce the risk of GER and may eventually contribute to a reduction in complications as well as an improvement in the quality of life of the patients and their caregivers.

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The Relationship Between Functional Disability and Depressive Mood in Japanese Older Adult Inpatients

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ABSTRACT

Depression is commonly found in older adult patients and is often associated with handicaps. The authors administered the Comprehensive Geriatric Assessment (CGA), including basic activities of daily living (BADL), instrumental activities of daily living (IADL), Mini-Mental State Examination (MMSE), Geriatric Depression Scale (GDS)-15, and a socioenvironmental questionnaire to 198 patients who were admitted to Nagoya University Hospital, to examine the relationship between depressive mood and various physical and socioenvironmental outcomes. The overall GDS-15 score was correlated with the BADL and IADL. The factor analysis extracted 4 factors from the GDS-15 subscales. The factors labeled "loss of morale and hope" and "memory loss and reduction of social activity" were highly correlated with both ADLs, social variables, and the MMSE score. The results reveal that factor analysis of GDS-15 will help in understanding the etiology of depressive mood, thereby contributing to better therapeutic approaches. (*J Geriatr Psychiatry Neurol* 2004; 17:93-98)

Keywords: depressive mood; Geriatric Depression Scale; Comprehensive Geriatric Assessment; factor analysis

Depression is one of the most insidious problems faced by older adults, and its incidence is increasing with the growth of an aging population. Koenig and Blazer reported that the prevalence of major depression was about 1% among community-dwelling older adults and that less severe depressive disorder was present in over 25%.[1] Moreover, they reported that the rate of major depressive disorder in older adult hospitalized patients with illness was more than 10 times greater than that of the unhospitalized aging population. Depression is not only psychologically traumatic but also quite costly[2] because it is related to psychosomatic symptoms resulting in a higher frequency of examination and prescription of drugs. Furthermore, depression also decreases the morale of older people and increases the risk of being housebound. Although it is very important to adequately diagnose and treat depression in its early stage, it often remains unrecognized or untreated.[3] One of the main reasons for this is that depressive symptoms often resemble those of the aging process itself, such as progressive cognitive deterioration or physical disabilities.[4]

The Geriatric Depression Scale (GDS) is a self-administered questionnaire with 30 items[5] and is recommended by the Royal College of Physicians and British Geriatrics Society as a valid screening method for depression in older adults.[6] A short form of the GDS (GDS-15) was developed later[7] and was translated into Japanese.[8] The validity and reliability of the GDS-15 have been confirmed in both community and hospital settings.[9-11] Several studies have subjected the GDS-15 data to a factor analysis, which is a statistical technique to analyze interrelationships within a set of variables, resulting in the construction of a few hypothetical variables. To our knowledge, however, there has been only 1 study involving factor analysis of the Japanese version of the GDS-15, reported by Schreiner et al in poststroke patients.[12] In addition, there have been few studies demonstrating the relationship between GDS-15 factor loading and disabilities in the older population.

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The GDS-15 is included as one of the components in the Comprehensive Geriatric Assessment (CGA), a tool developed in the late 1980s[13,14] to assess not only medical conditions but also overall functional status with respect to physical, psychological, and social problems of the older adults.

Although it is well known that depressive mood is often associated with functional disabilities, the mechanism by which the disabilities cause depressive mood in the older adults remains unclear. We hypothesized that some variables associated with functional disability may be associated with depressive mood. Therefore, we investigated the relationship between depressive mood and physical health and socioenvironmental variables in older adult inpatients. In addition, we attempted to clarify the structure of depression by performing a factor analysis of the GDS-15.

METHODS

Subjects

Among 355 consecutive patients aged 65 and older (mean age ± SD: 77.3 ± 6.8) who were admitted to Nagoya University Hospital between July 1998 and August 2001, patients who were admitted to nongeriatric wards were not included due to the absence of experienced CGA assessment team in the wards. Also, patients with communication impairments due to problems such as severe dementia or consciousness disturbance and patients under intensive care were not included in the study. If a patient was admitted more than once during the study period, only the data from the first admission was used for this analysis. As a result, 198 older adult patients in total were included in the study.

Measurements

The CGA was administered within a week after admission. The CGA included height; weight; Body Mass Index (BMI); blood pressure; basic activities of daily living (BADL), which were measured with the Barthel Index[15]; instrumental activities of daily living (IADL) using Lawton's scale[16]; Mini-Mental State Examination (MMSE)[17]; GDS-15; hearing ability and vision; communicative competence; and living environment including socioeconomic status. We scored IADL by 5 items (IADL-5), excluding food preparation, housekeeping, and laundry items from the Lawton's scale because the study samples included male patients, who did not normally perform these activities. The low scores of BADL and IADL-5 indicate greater functional disability. The GDS-15 is scored so that higher scores indicate a greater degree of depressive mood. The recent research clarified that the sensitivity of the GDS-15 was 97.3% and the specificity was 95.9% for screening major and minor depression when the cut-off score was set at 6/6+ in the Japanese geriatric population.[18] Socioenvironmental status was assessed by Ozawa's scale,[19] which includes items on economic, marital, family status, and the relationship between the patient and his or her family. The GDS-15 was self-administered by the patient. The attending nurse collected all other information by interview and/or assessment.

Statistical Analysis

Correlation coefficients were calculated by Pearson's method for parametric data and Spearman's for nonparametric data. We used the chi-square test with Yates correction and Fisher's exact test for categorical comparisons of the data. Differences in the means of continuous measurements between genders were tested using the Student's t test. In addition, after nonparametric data in the CGA were categorized into 2 groups (subjects with and those without a problem with respect to each parameter measured), the means of the continuous measurements between the groups were also compared by Student's t test. The internal consistency of the GDS-15 was calculated with Cronbach's alpha. Principal component analysis for the GDS-15 was performed with an eigenvalue of 1.0 or more as the extraction criterion, and factors were identified after Varimax rotation. The factor score, which shows the power of a factor's contribution, was calculated by regression method, which cumulated factor loadings of all items of GDS-15. In the present study, a higher score indicates a greater contribution of the factor to depressive mood. Differences in continuous variables among the disease groups were determined by 1-way analysis of variance (ANOVA). Tukey's test was used for multiple comparisons when homoskedasticity was assumed by Levene's method, and Dunnet's test was performed when homoskedasticity was not assumed. Multiple regression analysis, using the equation-building method with the variables of significant measures detected in the univariate analysis, was conducted to identify the variables contributing to GDS-15 scores. Values of $P < .05$ were considered to indicate statistical significance; all tests were 2-tailed. All statistical analyses were performed on a personal computer with the statistical package SPSS for Windows (Version 11.0 SPSS, Chicago).

RESULTS

Table 1 reports CGA variables for all patients, according to their diagnostic category. The mean GDS-15 score of all patients was 5.9 ± 3.8 SD, and 39.3% of the patients had scores above 6. The homoskedasticities were assumed in age, systolic blood pressure, BADL, IADL-5, and GDS-15, but not in BMI or MMSE. Significant intergroup differences were observed on the BADL and IADL-5, but not in BMI, MMSE, or GDS-15. The BADL score in patients with diabetes mellitus was higher than that in patients with collagen disease ($P = .005$), and the IADL-5 score in patients with diabetes mellitus was higher than that in patients

Table 1. Mean Values ± Standard Deviation of Comprehensive Geriatric Assessment (CGA) Variables by Admitting Diagnosis

Admitting Diagnosis	*n (%)*	*Age*	*BMI (kg/m²)*	*sBP (mm Hg)*	*BADL*	*IADL-5*	*MMSE*	*GDS-15*	*GDS > 6*
Neurological disease	40 (20%)	76.5 ± 6.6	20.9 ± 3.9	128.5 ± 23.7	16.9 ± 4.1	4.0 ± 1.3	24.9 ± 4.5	6.3 ± 37	42%
Cardiovascular disease	36 (18%)	77.7 ± 8.4	23.5 ± 3.8	132.8 ± 20.0	18.0 ± 3.7	4.0 ± 1.3	26.0 ± 4.3	5.7 ± 4.0	38%
Diabetes mellitus	34 (17%)	74.2 ± 5.3	23.5 ± 3.1	138.3 ± 19.4	19.0 ± 3.0*	4.5 ± 0.9*	26.6 ± 3.5	4.6 ± 3.5	27%
Psychological disease	20 (10%)	78.5 ± 6.5	20.0 ± 3.4	138.5 ± 22.3	17.9 ± 3.0*	3.1 ± 1.9*	22.4 ± 4.9	7.6 ± 3.8	15%
Gastroenterological disease	14 (7%)	78.9 ± 6.8	21.1 ± 4.8	132.3 ± 14.1	18.2 ± 3.2*	4.2 ± 0.9	25.9 ± 3.8	5.9 ± 4.7	64%
Collagen disease	12 (6%)	77.7 ± 5.1	21.6 ± 4.0	133.5 ± 20.6	14.2 ± 6.5*	3.3 ± 1.7	23.7 ± 4.7	5.4 ± 2.7	17%
Infectional disease	11 (6%)	83.1 ± 4.7	19.9 ± 3.0	122.0 ± 15.7	19.5 ± 0.8	4.8 ± 0.4	27.3 ± 2.8	2.8 ± 1.8	0%
Others	31 (16%)	78.0 ± 7.6	20.7 ± 3.5	142.4 ± 29.0	18.0 ± 3.9	4.3 ± 1.1	26.1 ± 4.1	6.3 ± 4.0	43%
Total	198 (100%)	77.3 ± 6.8	21.9 ± 3.8	133.9 ± 21.7	17.8 ± 3.8	4.1 ± 1.3	25.5 ± 4.3	5.9 ± 3.8	39%

Note: BMI = body mass index, sBP = systolic blood pressure, BADL = basic activities of daily living, IADL = instrumental activities of daily living, MMSE = Mini-Mental State Examination, GDS = Geriatric Depression Scale.

*$P < .05$.

Table 2. Principal Components (Varimax) Factor Analysis of the Geriatric Depression Scale-15

Items	*Factor 1 Unhappiness*	*Factor 2 Apathy and Anxiety*	*Factor 3 Loss of Hope and Morale*	*Factor 4 Memory Loss and Reduction of Social Activity*
1. Satisfied	***0.708***	0.270	0.061	−0.266
2. Dropped activities	0.058	***0.646***	0.350	−0.020
3. Emptiness	0.299	***0.621***	−0.134	0.179
4. Often bored	0.151	***0.675***	0.140	0.233
5. In good spirits	***0.627***	0.216	0.129	0.216
6. Afraid something bad will happen	0.336	***0.572***	0.163	−0.100
7. Feels happy	***0.769***	0.027	0.128	0.101
8. Often feels helpless	−0.186	***0.536***	0.493	0.013
9. Prefers to stay in	0.009	0.095	0.385	***0.445***
10. More problems with memory than most	0.082	0.074	0.043	***0.805***
11. Wonderful to be alive	***0.553***	0.077	0.458	0.033
12. Feels worthless	0.348	0.108	***0.605***	0.242
13. Full of energy	0.061	0.063	***0.753***	0.002
14. Feels situation is hopeless	0.270	0.235	***0.679***	0.090
15. Most people better off than self	***0.487***	0.396	0.013	0.368
Explained variance	2.4	2.2	2.2	1.2
Cumulative percentage of variance explained	16.6	31.5	46.3	54.8

Note: The factor score was calculated by regression method, which cumulated factor loadings of all items of GDS-15. Loadings in italic bold indicate those selected to define the factor.

with psychological disease ($P = .009$). The patients with psychological disease showed the highest mean score of GDS-15, (7.6 ± 3.8 SD). No significant intersex difference was observed in all parameters examined. Antidepressants had been administered to 7.2% of all patients, and to 9.0% of the patients with a GDS-15 score greater than 6.

The internal consistency of GDS-15 was found to be satisfactory, Cronbach's alpha being .83. Factor analysis of GDS-15 extracted 4 factors, whose loading values are shown in Table 2. The cumulative percentage of variance explained was 57.3%. Factor 1 represented "unhappiness," which included the items satisfied, in good spirits, feels happy, wonderful to be alive, and most people better off than self. Factor 2, "apathy and anxiety," was made up of the items, dropped activities, emptiness, often bored, afraid something bad will happen, and often feels helpless. Factor 3, "loss of hope and morale," included the items feels worthless, full of energy, and feels situation is hopeless. Finally, factor 4, "memory loss and reduction of social activity," included the items prefers to stay in and more problems with memory than most.

Table 3. Correlation Between Geriatric Depression Scale-15, Extracted Factors, and Parametric Data

Measure	*GDS-15*	*Factor 1 Unhappiness*	*Factor 2 Apathy and Anxiety*	*Factor 3 Loss of Hope and Morale*	*Factor 4 Memory Loss and Reduction of Social Activity*
Age	0.123	−0.001	−0.108	0.250**	0.166*
BMI	−0.141	0.006	−0.135	−0.121	−0.036
sBP	−0.038	−0.260	−0.040	−0.009	−0.101
BADL	−0.168*	−0.033	−0.044	−0.191*	−0.055
IADL-5	−0.201**	−0.076	0.023	−0.235**	−0.066
MMSE	−0.151*	−0.034	0.050	−0.167*	−0.214**

Note: Pearson's rho used for correlations. BMI = body mass index, sBP = systolic blood pressure, BADL = basic activities of daily living, IADL =instrumental activities of daily living, MMSE = Mini-Mental State Examination.

*$P < .05$. **$P < .01$.

Pearson's coefficients of continuous variables are shown in Table 3. The total GDS-15 score had a significant negative correlation with IADL-5 ($r = -.201$, $P = .005$), BADL ($r = -.168$, $P = .021$), and MMSE ($r = -.151$, $P = .034$). However, there was no significant relationship between the GDS-15 score and age, BMI, or systolic blood pressure.

The score of factor 3 (loss of hope and morale) correlated positively with age and negatively with IADL-5, BADL, and MMSE scores, whereas factor 4 (memory loss and reduction of social activity) showed a significant positive correlation with age and a significant negative correlation with MMSE score. However, there was no significant relationship between the scores of factor 1

Table 4. Relationship of Nonparametric Data in Comprehensive Geriatric Assessment With the Geriatric Depression Scale-15 and Extracted Factors

Measurement	*Percent With Problem*	*Spearman's ρ With GDS-15*	*t Test for Mean Score GDS-15*	*Factor 1 Unhappiness*	*Factor 2 Apathy and Anxiety*	*Factor 3 Loss of Hope and Morale*	*Factor 4 Memory Loss and Reduction of Social Activity*
Gender (male/female)	—	—	NS	NS	NS	–0.22/0.17**	NS
BADL (with/without problem)							
Grooming	7.1%	—	NS	NS	NS	0.75/–0.08**	NS
Feeding	8.1%	–0.087	NS	NS	NS	NS	NS
Bowel continence	12.2%	–0.062	NS	NS	NS	NS	NS
Using toilet	14.2%	–0.122	NS	NS	NS	NS	NS
Ambulation	16.8%	–0.102	NS	NS	NS	0.31/–0.09*	NS
Chair/bed transfer	16.8%	–0.142	7.1/5.6*	NS	NS	NS	NS
Dressing	17.8%	–0.122	NS	NS	NS	NS	NS
Bladder control	19.8%	–0.097	NS	NS	NS	NS	NS
Bathing	25.0%	—	6.9/5.5*	NS	NS	0.27/–0.12*	NS
Using staircase	29.9%	–0.271*	7.4/5.2**	NS	NS	0.33/–0.17**	NS
IADL(with/without problem)							
Going outside	10.4%	—	NS	NS	–0.41/0.10*	NS	NS
Using telephone	11.4%	—	NS	NS	NS	NS	NS
Managing money	20.3%	—	NS	NS	NS	NS	NS
Medication	37.1%	—	NS	NS	–0.14/0.15*	NS	NS
Shopping	39.4%	—	NS	NS	NS	0.21/–0.15*	NS
Physical (with/without problem)							
Seeing	23.1%	–0.141	NS	NS	NS	NS	NS
Hearing	23.0%	–0.091	NS	NS	NS	NS	NS
Communication	7.0%	–0.152*	8.2/5.7*	NS	NS	NS	0.51/–0.48*
Social							
Economic status (dependent/independent)	—	–0.163*	NS	NS	NS	NS	NS
Marital status (with/without spouse)	—	–0.148*	NS	NS	NS	0.20/–0.21**	NS
Familial status (alone/not alone)	—	–0.136	7.2/5.6*	0.50/–0.08*	NS	NS	NS
Family relation (with/without interaction)	—	–0.220*	NS	NS	NS	0.71/–0.03*	NS

Note: NS = not significant. t-test for mean score compared between 2 groups with or without problem for each item.

*$P < .05$. **$P < .01$. Dashes indicate not calculated because the items have less than 3 alternatives

(unhappiness) or factor 2 (apathy and anxiety) and other CGA variables.

The patients were divided into 2 groups depending on their score for CGA variables. Then we compared the difference between the GDS-15 factor scores and these 2 groups using Student's *t* test. The correlations of nonparametric data with the score of GDS-15 and the extracted factors are shown in Table 4. The GDS-15 score had a significant negative correlation with BADL (using staircase), communicative ability, economic and marital status, and family relationship. Patients having problems in using the staircase, bathing, chair/bed transfer, and communication showed a significantly higher GDS-15 score than the patients without these problems ($P < .001$, $P = .041$, $P = .034$, $P = .028$, respectively). Also, patients living alone showed a significantly higher GDS-15 score than those not living alone ($P = .043$). The statistical analysis revealed that the score of factor 3 (loss of hope and morale) was significantly higher among women ($P = .007$). Factor 3 had a much stronger relationship with some variables of BADL and IADL-5, such as grooming, using staircase, ambulation, bathing, and shopping, than it did with other factors. On the other hand, factor 2 (apathy and anxiety) was inversely correlated with going outside and managing medication.

Multiple regression analysis was performed to predict the score of GDS-15 with significant variables, which were using stairs, bathing, communicative ability, economic status, marital status, familial status, and the total score of MMSE. This analysis elicited a model with an adjusted R^2 of .144 ($P < .001$) (Table 5).

DISCUSSION

The mean GDS-15 score in this study was 5.9, which was higher than those in previous studies. In a recent study of 1343 Japanese community-dwelling older adults, the mean GDS-15 score was 2.0 and 23.7% scored 6 or higher.[20] Meanwhile, Patrick et al reported that the mean score of hospitalized patients in their geriatric rehabilitation unit was 3.8 ± 2.8 SD.[21] The higher GDS-15 scores obtained in this study may imply that worsening medical conditions resulting in admission to the hospital relate to increased depressive symptoms. In particular, the neurological disease group showed the highest mean GDS-15 score, which is in line with findings in previous studies that depression

Table 5. Coefficients of Regression Model for Geriatric Depression Scale-15

Variable	ß	Standardized ß	*T*	P *Value*
Using stairs	−2.48	−0.48	−4.27	< .001
Bathing	2.59	0.29	2.44	< .001
Communicative ability	−0.57	−0.04	−0.558	.016
Economic status	−0.48	−0.07	−0.917	.577
Marital status	−0.34	−0.09	−1.25	.360
Familial status	−1.02	−0.17	−2.17	.211
MMSE	−0.04	−0.04	−0.55	.584

Note: MMSE = Mini-Mental State Examination. GDS-15 = −2.48 × (Using stairs) + 2.59 × (Bathing) − 0.57 × (Communication) − 0.48 × (Economic status) − 0.34 × (Marital status) − 1.02 × (Family status) − 0.04 × MMSE. Total adjusted $R^2 = 0.144$, $P < .001$.

frequently occurs after stroke.[10,22,23] In the present study, antidepressants were administered to only 9.0% of the patients who had a GDS-15 score of greater than 6, which supports claims that depression is overlooked by clinicians, or is not treated adequately.[4]

The results of this study are consistent with previous findings that physical disabilities relate to depressive symptoms.[24-27] In the present study, the GDS-15 score was negatively correlated with the BADL and IADL. Three BADL items in particular, using staircase, chair/bed transfer, and bathing, had strong negative correlations with the GDS-15 score. These results indicate that loss of lower body strength and impaired mobility may affect patient's mood. A possible explanation for the difference is that depressive mood may be associated with impaired abilities to maintain normality in life such as immobility, rather than the severity of disabilities.

We also found a weak but significantly negative correlation between the GDS-15 and MMSE scores. The findings of previous studies regarding the relationship between depression and the severity of dementia are varying, which may be attributable to differences in study design.[28] Although many investigators have reported a decrease in the frequency of depression in advanced dementia,[29,30] no such association was found in this study probably because the cognitive impairment of the patients in this study was rather mild with mean MMSE score of 25.5 ± 4.3 SD, and no patients with advanced dementia were included.

Liu et al reported that being female, older, and without spouse were related to depressive symptoms among Chinese older adults.[31] Our results did not demonstrate a significant relationship between the GDS-15 score and either gender or age, but a higher GDS-15 score was significantly related with economic dependence, absence of spouse, and poor family relationship particularly with "living alone."

Thus far, many researchers have reported on the factor analysis of GDS-15, but the relationship between the factors extracted and the physical, psychological, and socioenvironmental status of the older adults has not been extensively investigated. We found that factor 3, "loss of morale and hope," was highly related with BADL and IADL. Meanwhile, factor 4, "memory loss and reduction of social activity," was related with age and MMSE, although factor 1 (unhappiness) and factor 2 (apathy and anxiety) were not correlated with any of those parameters examined, which means they may be normal aspects of disabled state and hospitalization. Some investigators have reported that sense of loss or environmental change can induce depression in the aged.[32,33]

GDS-15 is often included in CGA, which is a useful tool to comprehensively assess older adult patients. The meta-analysis conducted by Stuck et al demonstrated that CGA was effective in improving mortality and in reducing hospitalization.[34] However, there have been few studies using CGA results to identify specific clinical strategies for patient care. The present study demonstrates that factor analysis of GDS-15 helps health care staffs establish better therapeutic strategies for depressive mood of older patients. For example, the present findings suggest that intervention to assist in coping with the functional impairment may decrease depressive symptoms in subjects suffering from them. However, pharmacological interventions may be more appropriate for nondisabled patients.

In conclusion, we carried out a structural analysis of the GDS-15 in older adult inpatients and extracted 4 factors related with functional disabilities. Factor 3, "loss of morale and hope," and factor 4, "memory loss and reduction of social activity," were highly related with ADL, social variables, and cognitive impairment. In addition, the results suggest that factor analysis will allow improved assessment and medical support of older adult inpatients. Thus, we believe that the results have indicated an extended utility of the GDS-15 not only as a simple screening method for depressive mood but also as a tool for better therapeutic approaches.

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The Clock Drawing Test as a Valid Screening Method for Mild Cognitive Impairment

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Key Words
Clock drawing · Early diagnosis of dementia · Screening test · Cutoff point · Cahn's scoring protocol

Abstract
To validate the Clock Drawing Test (CDT) as a screening method for detecting mild cognitive impairment (MCI) and to find the appropriate scoring protocol and its cutoff point, we compared the sensitivity and specificity of three CDT protocols. Subjects included 219 outpatients with memory complaints, who were attending the geriatric memory clinic. Cahn's protocol, with a cutoff point of 7, was more successful at differentiating clinically diagnosed MCI subjects from normal elderly individuals, with higher sensitivity (74.7%) and specificity (75.6%), than were the other protocols. The CDT, as a handy screening method, may be useful for clinicians to reliably identify subjects with MCI, and it may contribute to early detection of dementia.

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Introduction

Early detection of dementia is an issue of growing concern because of improved clinical outcomes expected as a result of early therapeutic interventions or preventive approaches [1]. In terms of care, the diagnosis of cognitive deficits at an early stage, when the patient is still competent enough to make important decisions, can give the patients and their caregivers the opportunity to prepare for situations expected to occur as the symptoms progress (e.g. making environmental arrangements or educating the family), and also facilitate autonomic future planning (e.g. writing a living will, assigning durable power to an attorney or composing advanced directives) [2]. The term 'mild cognitive impairment' (MCI) was originally used to describe a transitional state between normal condition and Alzheimer's disease (AD) [3] and was first defined by Petersen et al. [4]. Recently, a revised and extended definition of MCI has been proposed that covers a broader range of cognitive impairment. It categorizes MCI into the following three subtypes: purely amnestic syndrome, impairment of a single nonmemory domain of cognition, and slight cognitive impairment in multiple domains of cognition [5]. It has also been suggested that enlarging the definition would allow the screening of more subjects at

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risk of dementia [6]. Although many detailed neuropsychological tests evaluating executive functions are available as screening instruments to quantify the degree of cognitive impairment, most of them are impractical for general physicians to administer in their clinical settings [2, 7]. To our knowledge, none of these neuropsychometric tests can contribute to the accurate diagnosis of MCI with reliable sensitivity and specificity.

The Clock Drawing Test (CDT) has been arousing the interest of clinicians and researchers as a convenient screening instrument for dementia, either by itself or as a part of a brief neuropsychological test battery. The CDT takes less than 2 min to administer, and it is easy to comprehend the instructions, making it suitable for elderly patients who may not be able to maintain concentration [8]. Previous replication studies, which applied various scoring systems, demonstrated that the CDT is a reliable method for the detection of dementia [9–12]. The CDT is relatively less affected by the level of education, language, and cultural background than are the other cognitive tests such as the Mini-Mental State Examination (MMSE) [13, 14]. The protocols of the CDT in published studies are various. They differ not only in the instructions (with or without predrawn circle, different time setting) but also in their scoring criteria. To obtain acceptable reliability for screening MCI among a target population, the cutoff points of the CDT applied in previous studies must be reexamined, since they may not be appropriate in populations with lower prevalence rates of dementia [9]. To date, there has been a dearth of studies examining the utility of the CDT in detecting cognitive deficits in their early stages, in particular MCI. Previous studies yielded conflicting results with limitations in terms of the criteria used for group assignment, the sample size, and the optimal cutoff points for different types of cognitive status [15, 16]. Besides, most previous studies emphasized the use of quantitative analyses of the CDT results, leaving detailed qualitative analyses of the results somewhat neglected. Despite the existence of reports regarding qualitative analyses of the CDT results in AD and vascular dementia (VD) patients, those focusing on MCI subjects are still lacking [17, 18]. The purpose of this study was to warrant the validity of the CDT as a screening method for detecting MCI by determining an appropriate scoring protocol with an optimal cutoff point and qualitative features.

Table 1. The neuropsychological test battery

Function	Test
Global cognitive function	MMSE
Orientation	MMSE-1, 2
Memory	MMSE-5
	Verbal recall (ADAS, paragraphs)
Verbal fluency	Initial letter
	Category
Visuospatial praxis	CDT, MMSE-11
	ADAS-7
Psychomotor speed	Digit symbol
Attention	Stroop test
	Digit Span

ADAS = The Alzheimer's disease assessment scale; ADAS-7 = constructional ability.

Methods

Participants

Subjects were recruited from outpatients at the geriatric memory clinic in the Nagoya University Hospital. A total of 219 subjects (male: 75, female: 144) aged 60 years and older who had either subjective memory complaints or memory loss reported by their informants participated in this study. Informed consent was obtained from all the participants or their primary caregivers after complete description of the study. The age of the participants ranged from 60 to 93 years (mean = 75.1 years, SD = 6.7 years). Years of education ranged from 3 to 24 years (mean = 10.2 years, SD = 2.8 years). None of the participants had a history of neurological or psychiatric disorders, and none had been diagnosed as having reversible causes of cognitive impairment. Routine physical examinations and neurological examinations had been carried out in all subjects. Subjects with receptive aphasias or visual impairment and those who had abnormal thyroid functions or serum vitamin B_{12} or folate levels in laboratory studies were excluded from the study. Magnetic resonance imaging of the brain was performed on all subjects. The Geriatric Depression Scale (GDS)-15 was applied as a screening test for excluding subjects with possible depression at a cutoff point of 8 [19]. Subjects were administered a neuropsychological test battery including the CDT, as shown in table 1 [20–22]. General cognitive impairment was assessed by the MMSE with a score <24 [23]. Information derived from a series of diagnostic evaluations, except for the CDT in the neuropsychological test battery, was reviewed by a team of experienced geriatricians at a case conference, and all the participants were categorized into five groups: normal elderly (NE), MCI, AD/senile dementia of Alzheimer's type (AD/SDAT) and mixed dementia, VD, and unclassified demented. The distribution of subjects by diagnostic category and sex is shown in table 2. Consensus diagnosis was made at the conference, using the Diagnostic and Statistical Manual of Mental Disorders Revised Third Edition (DSM-III-R) for dementia [24] as well as the National Institute of Neurological and

Table 2. Participant characteristics

	Whole sample	Nondemented		Demented		
		NE	MCI	SDAT[1]	VD	others
n; M/F	219; 75/144	41; 10/31	48; 21/27	102; 33/69	14; 6/8	14; 5/9
Age	75.1 (6.7)	72.7 (6.3)	74.7 (6.2)	76.0 (6.7)	76.9 (6.0)	74.9 (8.3)
Education	10.2 (2.8)	10.2 (1.8)	11.5 (3.7)	9.7 (2.4)	10.3 (3.0)	8.5 (2.5)
MMSE	24.4 (5.0)	28.4 (1.8)	27.2 (2.1)	22.2 (5.1)	20.5 (5.8)	20.6 (3.7)
CDT (Sunderland)	7.1 (2.4)	9.2 (1.1)	7.8 (2.1)	6.3 (2.3)	5.6 (2.5)	5.4 (2.3)
CDT (Rouleau)	7.0 (2.3)	8.7 (1.0)	8.0 (1.2)	6.3 (2.5)	5.6 (2.2)	5.6 (2.2)
CDT (Cahn)	6.1 (2.8)	8.4 (1.4)	7.1 (2.0)	5.2 (2.8)	4.1 (2.5)	4.1 (2.4)

Figures indicate means, with SD in parentheses.
[1] SDAT includes SDAT, AD and mixed dementia.

Communicative Disorders and Stroke and the Alzheimer's Disease and Related Association Work Group (NINCDS-ADRDA) criteria for probable AD to determine patients with AD/SDAT [25], and using the National Institute of Neurological and Communicative Disorders and Stroke and Association Internationale pour la Recherche et l'Enseignement en Neuroscience Work Group (NINCDS-AIREN) criteria for probable VD to determine VD patients [26]. Mixed dementia was diagnosed as probable mixed dementia, when there was a clinical indication that dementia was likely to be attributable to both conditions. In this study, patients with mixed dementia were incorporated into the AD/SDAT group as stated above. The diagnosis of MCI was made according to the following criteria: (1) not demented, (2) subjective memory complaint, (3) normal general cognitive functioning assessed by the MMSE (score, ≥ 24), (4) objective memory impairment and/or impairment in other cognitive domains as evidenced by scores >1.5 SD below the age-appropriate mean score of at least one or more neuropsychological tests examined, (5) autonomy in the basic activities of daily living [7, 27].

Measurements

The subjects were given a blank piece of paper and asked to follow a two-step instruction: 'First, draw a 10-cm diameter clock face with all numbers on it. Second, put hands on the clock to make it read 10:10.' The CDT was scored by a psychologist according to the rating scales of Sunderland et al. [28], Rouleau et al. [29] and Cahn et al. [30]. These three sets of scoring criteria were chosen because they are characterized by concrete scoring instructions with presentations of actual error types, unlike other scoring methods, which contain vague or equivocal expressions in their scoring criteria. The psychologist who was the CDT rater of the present study was not given any information about the participant, including performance on other cognitive tests or clinical diagnosis.

The scoring methods used in the present study are as follows. (1) The CDT by Sunderland et al. [28] (Appendix 1): this method is based on the assumption that the representation of the hands is the first and solely affected item (score 6–10 points), and additional errors in the representation of numbers and the clock face occur later (score 1–5 points), so that a 10-point scale is used, with higher numbers indicating better performance. (2) The CDT by Rouleau et al. [29] (Appendix 2): three components of the drawing (integrity of the clock face, 0–2 points; presence and sequencing of the numbers, 0–4 points, and presence and sequencing of the hands, 0–4 points) are independently assessed. The scoring method supplies 0–10 points, with higher numbers indicating better performance. (3) The CDT by Cahn et al. [30] (Appendix 3): this is considered to be a modified version of the method by Rouleau et al. [29]. The difference in the Cahn scoring method is that while Rouleau's scoring method is regarded as a quantitative scoring of 0–10 points, the administrator notes the presence of qualitative errors shown in Appendix 3 and adds the error numbers up as a qualitative score with a maximum number of 8. The global CDT score is calculated by subtracting the qualitative score from the quantitative score. A 10-point scale is used, with higher numbers indicating better performance.

Statistical Analysis

All statistical analyses were performed using SPSS 11.0J. for Windows. Differences in age and years of education among the diagnostic groups were tested using the Kruskal-Wallis test. To examine the relationships between the CDTs and other variables (age, years of education, GDS, MMSE score), correlations and their p values were calculated using the Spearman rank order correlation coefficients. Distributions of Cahn's qualitative errors were examined using χ^2 analyses and Ryan's procedure for multiple comparisons.

Results

The five diagnostic groups shown in table 2 did not differ in terms of age ($p = 0.0811$). As for the educational years, except for the unclassified demented group, the four definite diagnostic groups did not differ ($p = 0.0183$). Distributions of the MCI subtypes are shown in table 3. The three groups (amnestic, single nonmemory and multiple domains) did not differ in age and years of education ($p = 0.8623$, 0.3575, respectively).

Table 3. MCI characteristics

	MCI		
	amnestic	single nonmemory	multiple domains
n; M/F	10; 2/8	10; 4/6	28; 15/13
Age	74.6 (7.2)	74.0 (7.2)	75.0 (5.6)
Education	11.5 (3.0)	9.0 (3.5)	12.4 (3.0)
MMSE	26.8 (2.8)	28.9 (1.2)	26.9 (2.0)
CDT (Sunderland)	9.4 (0.5)	7.3 (1.8)	7.4 (2.3)
CDT (Rouleau)	9.3 (0.7)	7.5 (1.1)	7.7 (1.2)
CDT (Cahn)	9.3 (0.7)	6.1 (2.0)	6.7 (1.8)

Figures indicate means, with SD in parentheses.

Table 4. Correlation matrix

	Sunderland	Rouleau	Cahn
Age	0.146	0.182	0.180
Education, years	0.210	0.220	0.201
GDS	0.281	0.312	0.312
MMSE	0.459 *	0.492*	0.490*
Sunderland		0.836*	0.857*
Rouleau			0.979*

* $p < 0.001$.

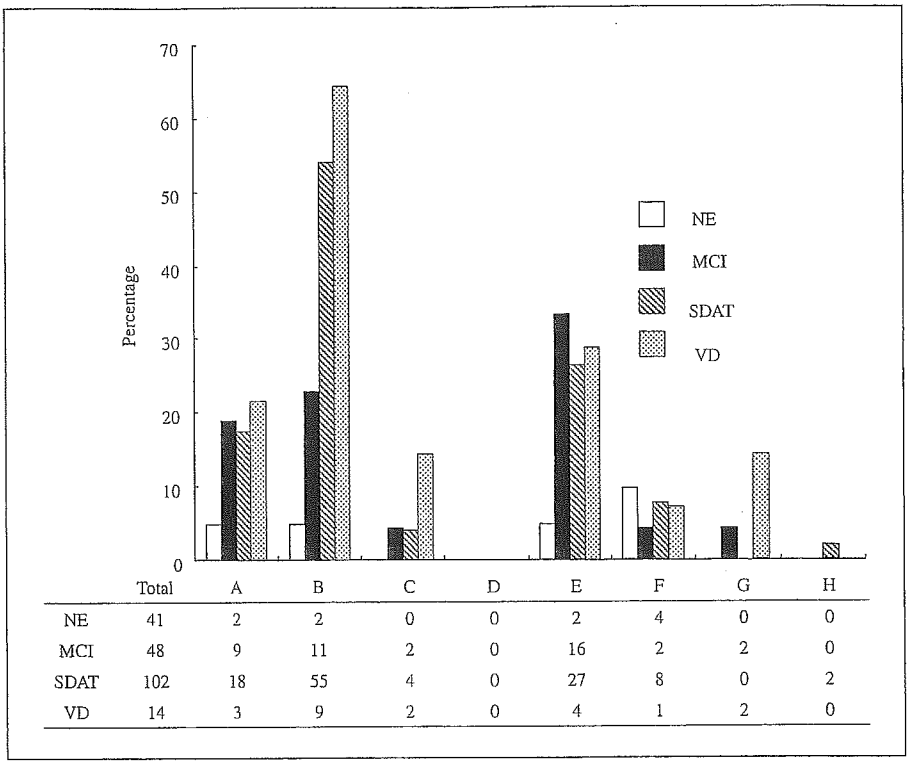
Correlations between the three CDT scores and other variables are presented in table 4. None of the CDTs correlated significantly with age, years of education, or the GDS score. However, all the CDTs correlated significantly with the MMSE score. Within the three CDTs, the scores correlated significantly with each other. In particular, the Cahn and Rouleau scores correlated with the highest correlation coefficient ($r = 0.979$, $p < 0.0001$).

We calculated the sensitivities and specificities with different CDT cutoff points to examine the discriminatory power of the CDTs for differentiating MCI and demented subjects from NE (table 5). The analyses demonstrated that Cahn's protocol had the highest discriminatory power at a cutoff point of 7, with a sensitivity of 74.7% and specificity of 75.6%.

Observed error types in the four definite diagnostic categories using Cahn's criteria for qualitative analysis are presented in figure 1. The four definite diagnostic groups did not differ in terms of age and years of education. The letters 'A' to 'H' represent Cahn's qualitative error types, which are described in Appendix 3. Regarding the distribution of error types in each group, only a few errors were noted in the NE group according to Cahn's criteria. In the MCI group, E (planning deficit) was the most frequent (16 of 48 cases), followed by B (conceptual deficit) and A (stimulus-bound response; 11 and 9 of 48 cases, respectively). In the AD group (SDAT/AD/MIXED), B was the most frequent (55 of 102 cases, 53.9%), followed by E (27 of 102 cases, 26.5%) and A (18 of 102 cases, 17.6%). In

Table 5. Sensitivities and specificities (%)

Cutoff point	Sunderland		Rouleau		Cahn	
	sensitivity	specificity	sensitivity	specificity	sensitivity	specificity
10	100.0	0.0	100.0	0.0	100.0	0.0
9	93.8	48.8	96.1	17.1	96.1	17.1
8	66.0	90.2	78.1	65.9	82.6	65.9
7	61.2	95.1	56.7	92.7	74.7	75.6
6	42.7	95.1	36.5	95.1	60.1	92.7
5	38.2	95.1	24.7	97.6	44.4	95.1
4	26.4	100.0	18.5	100.0	33.7	97.6
3	10.0	100.0	11.8	100.0	23.0	100.0
2	5.1	100.0	0.8	100.0	14.6	100.0
1	1.1	100.0	0.5	100.0	10.6	100.0



	Total	A	B	C	D	E	F	G	H
NE	41	2	2	0	0	2	4	0	0
MCI	48	9	11	2	0	16	2	2	0
SDAT	102	18	55	4	0	27	8	0	2
VD	14	3	9	2	0	4	1	2	0

Fig. 1. Comparison of error types among the four diagnostic groups: NE, MCI, SDAT, (represents SDAT, AD and mixed dementia), and VD. The horizontal scale (A–H) represents Cahn's qualitative error types: A = Stimulus-bound response; B = conceptual deficit; C = perseveration; D = neglect of hemispace; E = planning deficit; F = nonspecific spatial error; G = numbers written on the outside of the clock, and H = numbers written counterclockwise. The bottom table is the matrix showing participants' actual number of errors in the four diagnostic groups.

the VD group, B was the most frequent (9 of 14 cases), followed by E and A (4 and 3 of 14 cases, respectively). The χ^2 analysis comparing the frequency of Cahn's error types made by the four diagnostic groups revealed that there was a significant effect of diagnosis in all error types ($p < 0.0001$).

Discussion

While various CDT scales are available for detecting dementia, few studies have examined the adequate scoring protocol and optimal cutoff point for screening MCI. With the aim of detecting dementia at an early stage, particularly MCI, the present study compares the three scoring methods, all of which were found to be independent of years of education and depression scale, which is in keeping with the findings by Shulman et al. [8]. In addition, the CDT scores determined using the three scoring methods correlated with MMSE scores with high statistical significance, as confirmed in previous studies [12, 31, 32]. In most of the former studies, the cutoff points of CDTs were provided with the aim of distinguishing a demented state or AD from normal cognition. Recently, Powlishta et al. [16], choosing 6 different scoring criteria of the CDT for comparing subjects without altering the cutoff points determined for dementia in each original CDT criterion, have reported that the CDT was a poor screening method for very mild dementia. The sensitivity and specificity for detecting MCI by the CDT obtained in the current study were satisfactory. The discrepancy between the results of the study by Powlishta et al. [16] and those of the current study may be due to different cutoff points. Comparison of sensitivities and specificities among the three CDT protocols revealed that the Cahn scale had the best discriminatory power at the cutoff point of 7. Thus, the results may indicate that Cahn's protocol is the most suitable method for screening MCI in general practice. As shown in table 3, the analyses based on MCI subtypes suggest that subjects with amnestic MCI cannot be screened by the cutoff point we consider optimal for differentiating MCI subjects from normal individuals. This may simply imply that MCI subjects without deficits in the cognitive domain do not lose scores on the CDT, but we need further investigation to warrant this notion, given the limited number of participants included in this study. However, as we acknowledge the significance of including MCI subtypes other than the amnestic type, we believe that the

present findings would provide useful information for clinicians for screening subjects at risk of dementia in earlier stages.

We also examined the error types in MCI subjects using Cahn's qualitative criteria and compared them with the results in the NE and subjects with dementia. In what follows, impairment underlying each type of frequent error is disclosed [11, 17, 30]:

(A) stimulus-bound response: disturbance of inhibition in executive control functioning, an aspect of the frontal cortical function;

(B) conceptual deficit: loss of semantic memory usually evoked by the word 'clock';

(C) perseveration: an aspect of frontal dysfunction, and

(E) planning deficit: suggested to be associated with visuospatial constructional/frontosubcortical dysfuntion.

As shown in figure 1, error type E (planning deficit) could be a distinctive feature of MCI, which is represented by imprecise gaps before 12, 3, 6, or 9 of the numbers arranged in the clock face, or by clock hands drawn not from the center of the clock face. This type of error is considered to represent the inability to form a strategy for drawing a clock, presumably due to frontosubcortical dysfunction. The frequency of conceptual deficit in the MCI group was significantly lower than that in the SDAT/AD/MIXED and VD group. The conceptual deficit reflects a loss or deficit in accessing knowledge of the attributes, features, and meaning of a clock, and this category includes misrepresentation of the clock itself and the time on the clock [30]. Eleven out of 41 MCI subjects made this type of error; the difference in frequency between the MCI and the other groups' subjects did reach statistical significance. The SDAT/AD/MIXED and VD groups made this type of error with a frequency of 50% or above, which was statistically higher than that in the MCI and NE group, and that in the MCI being again higher than that in the NE group. Further investigations with increased number of subjects may clarify detailed characteristics of the clock drawing in MCI or its subgroups.

Between SDAT and VD subjects, no significant difference in error types was identified. This might be because of the relatively small number of patients in the VD subgroup in the current study, which may thus have influenced the statistical analysis. The previous study showed that the frequency of spatial and/or planning deficit was significantly higher in patients with mild VD than mild AD, and in patients with moderate VD, the frequency of graphic difficulties was significantly higher than in moderate AD [17]. These assumptions derived from the observations in this study may help to guide and benefit from future studies with larger numbers of subjects.

Although the CDT cannot be used solely for clinical diagnoses, the CDT, as a simple screening method, provides objective and graphic documentation of cognitive deficits that can be shared by a wide range of clinicians. In conclusion, among the three scales examined in this study, the Cahn scoring method at a cutoff point of 7 is the most likely indicator for MCI. Petersen et al. [7] recommended the CDT using Cahn's protocol as an optional instrument for brief cognitive assessment, as an addition to a general cognitive screening test, e.g. MMSE. We believe that the results obtained in the current study provide important evidence of the validity of the CDT as one of the useful screening method for discriminating MCI from normal cognition.

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Appendix 1
Sunderland's protocol: a priori criteria for evaluating clock drawings

10–6	Drawing of clock face with circle and numbers is generally intact
10	Hands are in correct position
9	Slight errors in placement of the hands
8	More noticeable errors in the placement of hour and minute hands
7	Placement of hands is significantly off course
6	Inappropriate use of clock hands
5–1	Drawing of clock face with circle and numbers is not intact
5	Crowding of numbers at one end of the clock or reversal of numbers
4	Further distortion of numbers sequence; integrity of clock face is now gone
3	Numbers and clock face no longer obviously connected in the drawing; hands are not present
2	Drawing reveals some evidence of instructions being received but only a vague representation of a clock
1	Either no attempt or an uninterpretable effort is made

10 = Best, and 1 = worst.

Appendix 2
Rouleau's protocol: the score is calculated by a sum of three components (I, II, III)

I Integrity of the clock face (maximum: 2 points)
- 2 Present without gross distortion
- 1 Incomplete or some distortion
- 0 Absent or totally inappropriate

II Presence and sequencing of the numbers (maximum: 4 points)
- 4 All present in the right order and at most minimal error in the spatial arrangement
- 3 All present but errors in spatial arrangement
- 2 Numbers missing or added but no gross distortions of the remaining numbers; numbers placed in counterclockwise direction or all present but gross distortion in spatial layout (i.e. hemineglect, numbers outside the clock)
- 1 Missing or added numbers and gross distortions
- 0 Absence or poor representation of numbers

III Presence and placement of the hands (maximum: 4 points)
- 4 Hands are in correct position and the size difference is respected
- 3 Slight errors in the placement of the hands or no representation of size difference between the hands
- 2 Major errors in the placement of the hands
- 1 Only one hand or poor representation of two hands
- 0 No hands or perseveration on hands

Appendix 3
Cahn's protocol: the global score is calculated by subtracting qualitative score (II) from quantitative score (I)

I Quantitative CDT score = maximum 10 points: assesses the presence and correctness of the clock; the clock face (0–2 points), the placement of the hands (0–4 points) and the placement of the numbers (0–4 points)

II Qualitative CDT score = maximum 8 points: summary of the following errors
- 1 Stimulus-bound response: the tendency of the drawing to be dominated or guided by a single stimulus
- 2 Conceptual deficit: this error type reflects a loss or deficit in accessing knowledge of the attributes, features and meaning of a clock
- 3 Perseveration: the continuation or the recurrence of activity without an appropriate stimulus
- 4 Neglect of left hemispace: all attributes of the clock are written on the right half of the clock face
- 5 Plannning deficit: this error type is represented by gaps before 12, 3, 6 or 9
- 6 Nonspecific spatial error: a deficit in the spatial layout of numbers, without any specific pattern in spatial disorganization
- 7 Numbers written on the outside of the clock: numbers written either around the perimeter of the circle or the circle itself
- 8 Numbers written counterclockwise: arrangement of the numbers with '12' at the top of the clock face and then continuing around in a counterclockwise fashion

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PREVENTION OF GASTROESOPHAGEAL REFLUX USING AN APPLICATION OF HALF-SOLID NUTRIENTS IN PATIENTS WITH PERCUTANEOUS ENDOSCOPIC GASTROSTOMY FEEDING

To the Editor: Although percutaneous endoscopic gastrostomy (PEG) feeding is widely used as a convenient method of long-term nutritional support,[1] administration of liquid nutrients often accompanies complications such as vomiting or diarrhea. Gastroesophageal reflux (GER) presumably causes vomiting, which may result in aspiration. Therefore, half-solid nutrients were used for PEG feeding, and whether this approach can reduce GER was examined.

Seventeen patients (mean age ± standard deviation = 79.9 ± 10.5) who were on PEG feeding participated in this study. Written informed consent was obtained from all patients. Liquid or half-solid nutrients were administered via PEG tubing in a randomized order. Half-solid nutrients were prepared by mixing 5 g of agarose with 500 mL of liquid nutrients diluted with the same volume of water. Incidence of GER was assessed using computed tomography (CT) scan of the esophagus. Liquid nutrients were administered over 15 minutes in portions of 400 mL containing 20 mL of the water-soluble contrast material, Gastrografin® (methylglucamine diatrizoate). The half-solid nutrients were administered via bolus injections of the same volume of nutrients, which were contained separately in 50 mL syringes. Thirty minutes after the administration, a CT scan was performed in 1-cm-thick slices of the esophageal portion. GER was confirmed if the Hounsfield number exceeded 100 in each slice examined. A Hounsfield number of 100 was employed because it can unequivocally distinguish the mixture of the nutrients containing contrast material from the esophageal and other surrounding tissues. A radiologist who was not informed of the type of nutrients used assessed the CT images. Statistical comparison of the incidence of GER between the two types of nutrients was made using McNemar test.

GER was confirmed in 10 of the 17 subjects (58.8%) when they received liquid nutrients. By contrast, when they received half-solid nutrients, only four of 17 subjects (23.5%) showed evidence of GER from CT findings ($\chi^2 = 6.0$, $df = 1$, $P = .014$, by McNemar test) (Table 1).

The advantages of PEG feeding over nasogastric feeding have been discussed elsewhere, although there have been some complications reported.[2] Of the complications, vomiting can be a cause of fatal aspiration due to a reflux of the administered nutrients.[3] The tubing used for PEG feeding has made it possible to apply half-solidified nutrients, which we hypothesized would cause less reflux from the stomach.[4] As expected, less evidence of GER was observed when using half-solid nutrients than when using

Table 1. Occurrence of Gastroesophageal Reflux by Liquid and Half-Solid Nutrients

			Gastroesophageal Reflux		Range of Reflux*		Distance from the Esophageal-Cardiac Junction†	
Age	Sex	Clinical Profile	Liquid	Half-Solid	Liquid	Half-Solid	Liquid	Half-Solid
82	F	Dementia	(–)	(–)				
81	F	Dementia	(–)	(–)				
90	F	Dementia	(+)	(+)	7	6	13	13
53	F	Cerebral infarction	(–)	(–)				
87	F	Dementia	(+)	(–)	4		13	
80	F	Dementia	(+)	(+)	9	4	9	10
82	M	Dementia	(+)	(+)	4	4	13	13
87	F	Cerebral infarction	(+)	(–)	1		4	
84	M	Cerebral infarction	(+)	(–)	12		15	
68	F	Cerebral infarction	(+)	(–)	13		13	
82	F	Dementia	(–)	(–)				
89	F	Cerebral infarction	(–)	(–)				
91	F	Cerebral infarction	(+)	(–)	1		2	
84	F	Cerebral infarction	(+)	(+)	15	10	15	10
87	F	Dementia	(–)	(–)				
68	M	Cerebral infarction	(–)	(–)				
64	M	Cerebral hemorrhage	(+)	(–)	5		8	

*Number of slices in which contrast materials were confirmed in the esophagus.
†Distance from the esophageal-cardiac junction to the upper limit of the slices where contrast materials were confirmed (cm).

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